SCHILLER

CARDIOVIT AT-6

OPERATING MANUAL

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Art. No. 2.510019
Issue 28.1992

Terms of Warranty

The CARDIOVIT AT-6 is warranted against defects in material and manufacture for the duration of one year (as from date of purchase). Excluded from this guarantee is damage caused by an accident or as a result of improper handling. The warranty entitles to free replacement of the defective part. Any liability for subsequent damage is excluded. The warranty is void if unauthorized or unqualified persons attempt to make repairs.

In case of defect, send the apparatus post-paid to your dealer or directly to the manufacturer.

The manufacturer can only be held responsible for the safety, reliability, and performance of the apparatus if:

- assembly operations, extensions, re-adjustments, modifications, or repairs are carried out by persons authorized by him, and
- the electrical installation of the relevant room complies with IEC requirements, and
- the CARDIOVIT AT-6 is used in accordance with the operating instructions.

CARDIOVIT AT-6

Operating Manual

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SAFETY

This unit is classified CF (⊣♥⊢). This means that the patient connection is fully isolated and defibrillation protected and that the unit is also suitable for intracardiac application. Protection against defibrillation voltages is only ensured, however, if the original Schiller patient cable is used.

For ECG recordings it must be ensured that neither the patient nor the conducting parts of the patient connection nor the electrodes (including the neutral electrode) come into contact with other persons or conducting objects (even if these are earthed).

The original Schiller patient cable is provided with special safety devices to offer protection against burns from HF surgical equipment. Incorporated protective resistors prevent or reduce the passage of defibrillation or HF currents through the electrode leads.

special care must be exercised when using *high frequency surgical equipment* together with an electrocardiograph: the active surgical electrode should always be placed at least 15 cm from the nearest electrode.

For a *defibrillation*, the protection against overvoltages fitted in the patient cable is indeed sufficient, but here too, the necessary caution must be observed. If possible, the patient should be disconnected temporarily from the ECG unit during defibrillation.

There is no danger when using the ECG unit for a *pacemaker patient* or with simultaneous use of other electrical stimulation equipment, however, the stimulation units should only be used at a sufficient distance from the electrodes. In case of doubt, the patient should be disconnected from the ECG recording unit.

If *several units are coupled*, there is a danger of summation of the lead currents. It must be determined in each case before coupling (e.g. by consulting the manufacturer) whether the units are suitable for this purpose.

Chapter 1

GETTING STARTED

CONTENTS

1. INTRODUCTION

The CARDIOVIT AT-6 is equipped with a highly sophisticated technology enabling it to be used as a simple electrocardiograph or as a complex unit for many different applications. The CARDIOVIT AT-6 is easy to operate, for despite its versatility the automatic programs are started by pressing a single key. The options and programs allow the performance of the CARDIOVIT AT-6 to be adapted exactly to your particular needs.

With the CARDIOVIT AT-6 you can record resting ECGs and print them in many different formats. There is also an exercise test program for the recording of exercise ECGs and several printing formats for long-term rhythm recordings are at your disposal.

2. INSTALLATION

2.1 Location

Do not keep or operate the apparatus in a wet, moist, or dusty environment. Also, avoid exposure to direct sunlight or heat from other sources. Do not allow the unit to come into contact with acidic vapours or liquids as such contact may cause irreparable damage.

Furthermore, the unit should not be placed near X-ray or diathermy units, large transformers or motors.

WARNING: This apparatus should not be operated in areas with danger of explosion.

2.2 Potential Equalisation

The yellow/green ground lead can be connected to the potential equalisation and then to the connection marked ⏚ on the rear of the CARDIOVIT AT-6.

2.3 Interference

Due to the digital processing of the ECG signals, the influence of disturbances and artefacts are reduced to a minimum. 50 Hz interferences are suppressed by the AC interference filter, an adaptive digital filter, without attenuating or distorting the ECG. When using the unit, make sure that no sources of interference (such as electrotherapy units, X-ray appliances, strong lamps or current conductors) are nearby.

2.4 Power Supply

The CARDIOVIT AT-6 can be operated either from the mains supply or from the built-in rechargeable battery. For **mains operation** and recharging of the battery, connect the AT-6 to the mains supply and switched it on with the green **O/I** power switch located on the front of the unit. The power switch is illuminated when in the on position.

In **battery operation**, the unit is powered by the rechargeable 12V accumulator. This mode of operation is indicated by the control lamp to the right of the **ON** key.

As soon as the battery voltage drops below a certain minimum (25% of total charge), the battery control lamp starts to blink. After this indication first appears, there is still enough capacity left to record ECGs for another half an hour.

To recharge the battery, the CARDIOVIT AT-6 is connected to the mains supply (power switch on!). A totally discharged battery is completely recharged after 12 hours. After approx. 3 hours, however, 80% of the battery charge will be regenerated.

The CARDIOVIT AT-6 can be permanently connected to the mains supply without any danger of damage to either the battery or the unit.

3. SWITCHING ON AND OFF

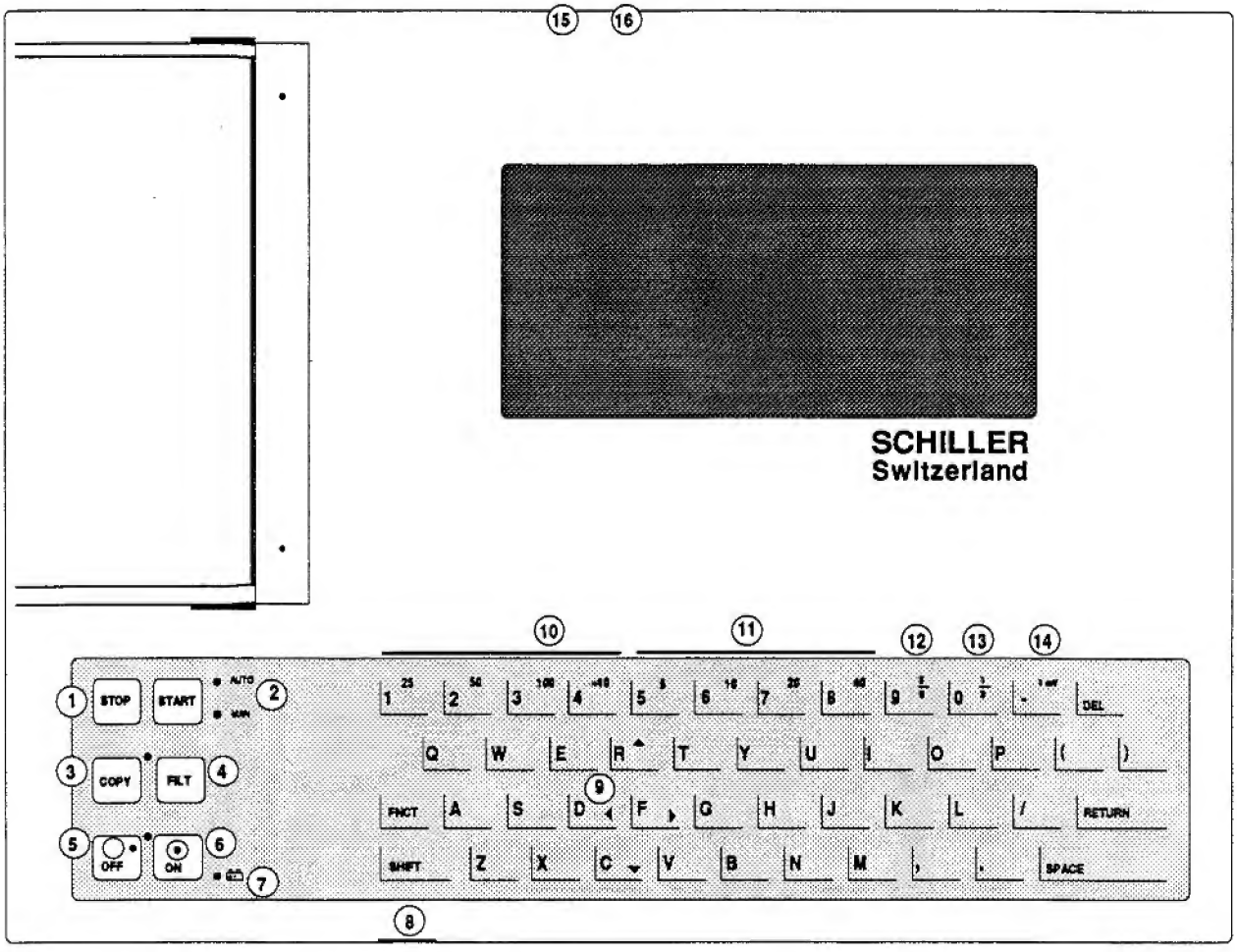
In mains operation, the CARDIOVIT AT-6 is switched on by pressing the green **O/I** power switch (8) on the front of the unit. The switch is illuminated when in the on position. To bring the unit into the active operating condition, press the green **ON** key (6) on the keyboard.

In battery operation, it is only necessary to press the green **ON** key on the keyboard.

The CARDIOVIT AT-6 is now in Automatic mode.

To switch the unit off, press the red **OFF** key (5) on the keyboard. To switch off the mains supply, press the green **O/I** switch on the front of the unit and the lamp will no longer be illuminated. This switch can however remain in the on position and the battery will automatically be recharged as necessary.

4. MAIN ELEMENTS OF THE CARDIOVIT AT-6



4.1 Functional Description

(1) **STOP:** interrupts the printout.

(2) **START:**
Automatic mode: The last 10s of the ECG are stored, analysed and printed in the selected format.
Manual mode: ECG printout is started.

(3) **COPY:** For copies of the ECG in automatic mode or to switch from manual to automatic mode.

(4) **FILT:** switches myogramm filter on and off. Control lamp illuminated when switched on.

(5) **OFF:** switches unit off.

(6) **ON:** switches unit on.

(7) **Battery control:**
Illuminated: battery operation
Extinguished: mains operation
Blinking: battery is low (connect unit to mains supply!)

(8) **Power switch:** Switched on for mains operation and for recharging the battery.

(9) **Lead selector keys**: lead group selected with keys **D<** and **F>**, single lead selected with key **C**.

(10) **Chart speed selector keys**: The last key (+10) divides the values of the other keys by 10.

(11) Keys for selecting the **sensitivity**.

(12) Key for selecting the **number of printed leads**.

(13) Key for selecting **the number of leads on the screen**.

(14) **Calibration** key.

(15) Mains connection.

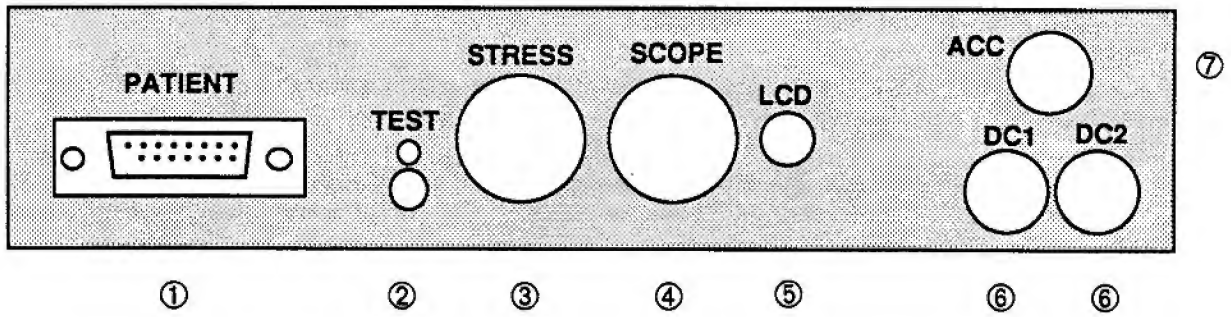
(16) Connection for ground lead.

4.2 Alphanumeric Keyboard

The main keyboard functions are as follows:

Key	Function
A	Format for automatic mode
C	Selection of a single lead
D	Selection of a lead group
E	Exercise test program
F	Selection of a lead group
G	Storage of base setting
H	List of functions
I	MTA identification (temporary)
J	User identification (permanent)
L	User-programmable lead group
M	Switch to manual mode
N	Rhythm and heart rate monitoring *(Option)*
O	Pulmonary function testing *(Option)*
P	Entering patient data
Q	Switching on/off acoustic QRS indication
R	Format for rhythm mode
S	Store ECG in memory (not available if EXEC option installed)
T	Self-test
U	Adjusting clock and calendar
V	Various machine settings
X	RS-232 control *(Option)*
Y	Stop ECG-monitor (freeze)
Z	Memory mode (not available if EXEC option installed)
FNCT	Switching to ECG monitor (monitor mode) or releasing the screen after "freeze" (key Y)
RETURN	Moving to next line or to next page, confirm entry
DEL	Delete characters
$\frac{3}{6}$	Channel selector for printout, 3 or 6 channels
$\frac{1}{3}$	Channel selector for display, 1 or 3 channels

4.3 **Connector Panel** (right-hand side of unit)



(1) **PATIENT** Socket for patient cable
CF rated: fully floating and isolated, defibrillation protected, suitable for intra-cardiac application.
Caution: Defibrillation protected only if used with the original patient cable.

(2) **Test** socket for electrode leads with control light

(3) **'STRESS'** or **'ERGO'** Exercise Test Interface

(4) **Scope** output

(5) **LCD** Knob for adjusting the contrast of the screen

(6) **DC1, DC2** DC inputs 0.5 V/cm

(7) **ACC** for connection of footswitch, QRS trigger

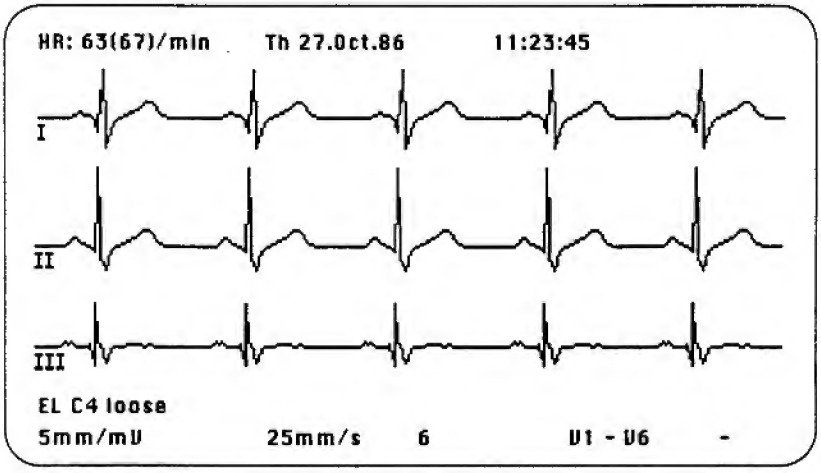
NOTE: When the optional RS-232 serial interface is installed, the RS-232 connection is located on this panel, to the right of the ACC and experimental input connections. The optional video connection is located on the rear of the unit.

4.4 Liquid Crystal Display

The liquid crystal display (LCD) performs both as an ECG monitor and as an alphanumeric display for menu selection, data input and the provision of important information.

To obtain good visibility of the screen contents, adjust the contrast by means of the **LCD** knob on the right-hand side of the unit. The screen is best visible if fully illuminated.

As soon as the patient is connected to the patient cable and the unit is switched on, the ECG is recorded and presented on the screen as follows (if no patient is connected, the same display appears but without ECG traces):



(1)
(2)
(3)

(1): Heart rate: mean value of 8 heart beats, in brackets beat-to-beat measurement; day of the week, date, time

(2): Line for system messages: Here for example, poor or no contact of electrode C4

(3): Sensitivity, recording speed, number of printed leads, selected lead group, function status

Together with the ECG tracings, heart rate (mean value of 8 heart beats and beat-to-beat measurement), day of the week, date and time are listed on the top line of the screen. At the bottom, sensitivity and recording speed as well as the number of leads selected for printing, the lead group selected and function status (ie "R" will be given here when in the Rhythm mode) are indicated. The displayed leads are identified on the left-hand side.

If any disturbances (e.g. loose electrodes, empty paper compartment) occur, they are signalled on the second lowest line. These disturbances have to be removed before ECG recording can take place.

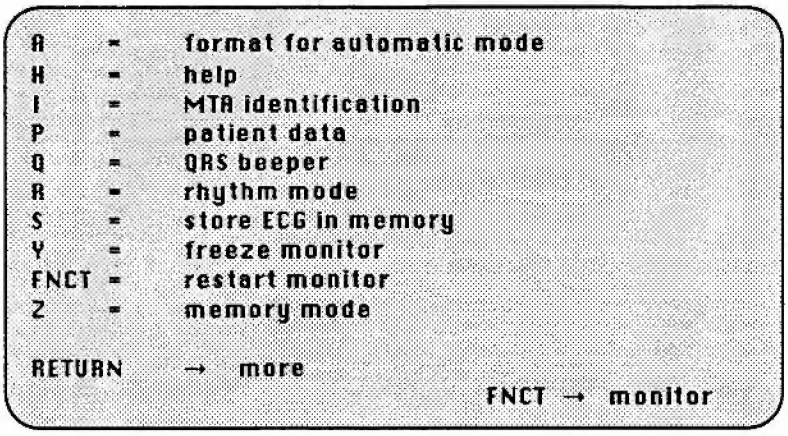
4.5 Freeze Screen

The ECG shown on the screen can be frozen by pressing key **Y**. To release it again, press **FNCT**. By this manipulation, the ECG on the screen can be examined more closely. The recording of the ECG continues while the screen is frozen.

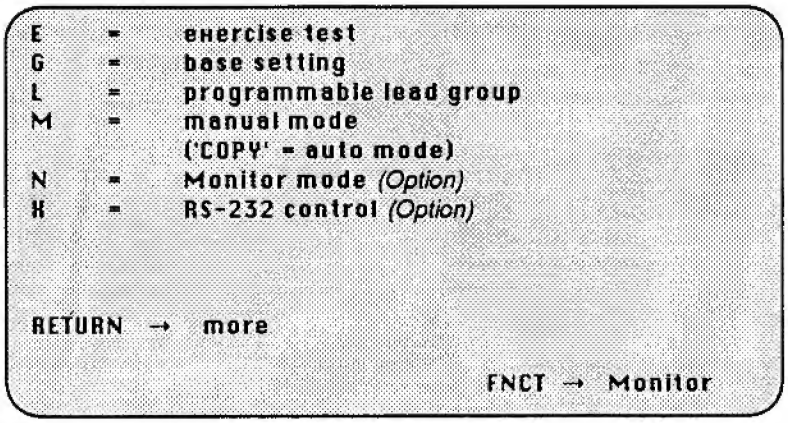
It is not possible to print directly the contents of the screen. There is, however, enough time (10 seconds) to retain and print out the event of interest by pressing the **START** key.

5. MENU ACCESS

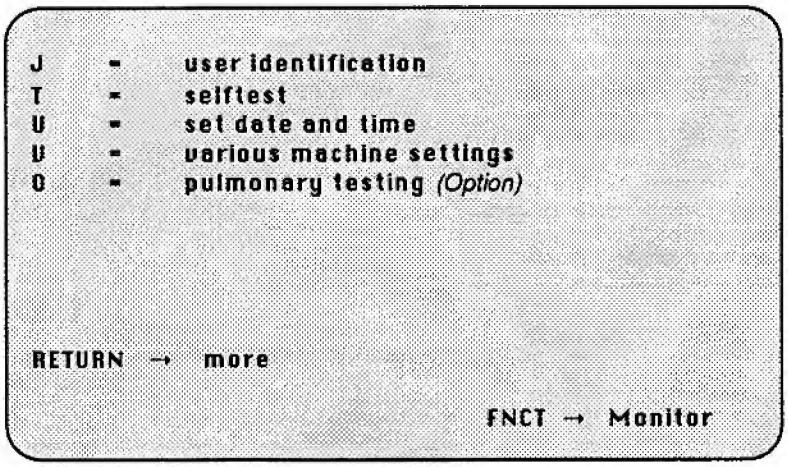
To call up a particular menu, simply press the corresponding key on the keyboard for the function you require. Until you are familiar with all the functions, the best way to proceed is to press key **H** on the keyboard and the first page of a list of functions is displayed as follows:



Press **RETURN** to move on to the second page:



Press **RETURN** to move on to the third page:



By pressing the indicated character on the alphanumeric keyboard, the function to be performed is called up or the command given is executed.

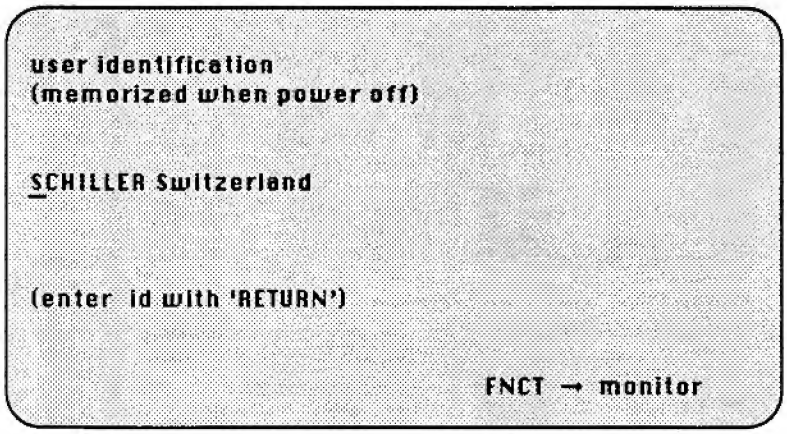
NOTE: Functions S and Z are not operable when the EXEC exercise testing option is installed.

To return to the Monitor mode, press **FNCT**.

6. USER IDENTIFICATION

This menu is used to enter the name of the physician, clinic or department which will then be printed on each ECG. The input is stored permanently, i.e. it is not deleted when the unit is switched off.

Press letter **J** and the following appears on the display:



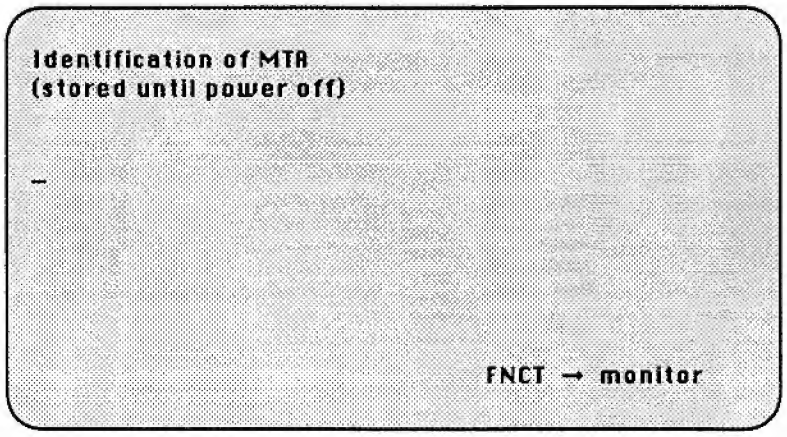
Using the keyboard, enter the desired user identification. The maximum length of the entry is 30 characters. Press **RETURN** to store the new identification and confirmation is given on the display. A change is made by simply typing over the existing entry and pressing **RETURN**.

Press **FNCT** to return to the Monitor mode.

7. MTA IDENTIFICATION

In order to mark the ECG with the name or identification of the person in charge of the recording, you can make a temporary input by means of this menu. The entry is stored until the unit is switched off or a new entry is made.

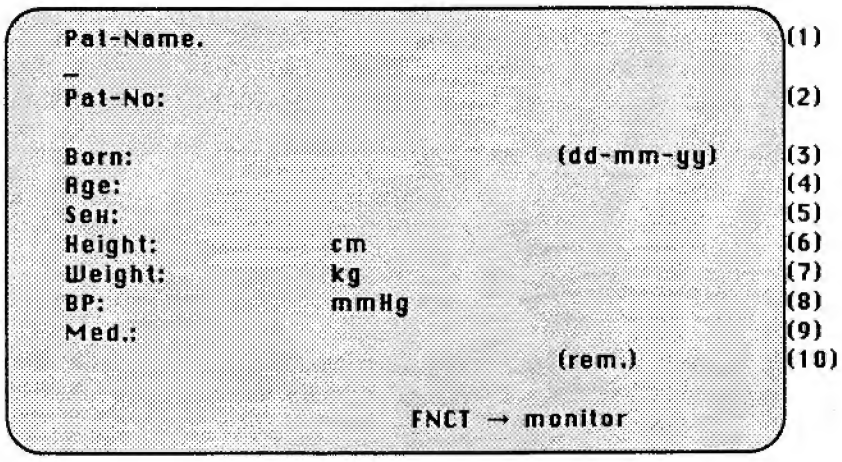
Press letter **I** and enter the name or any other identification (up to 22 characters).



Press **FNCT** to return to the Monitor mode.

8. INPUT OF PATIENT DATA

Each ECG is printed with the name and other information concerning the patient. Before beginning an ECG recording, the patient data should be entered. On the keyboard, press letter **P** in order to call up the menu for patient data input as follows:



(1): Patient name: maximum length 22 characters
(2): Patient number: maximum length 22 characters
(3): The date of birth has to be entered in figures in the order day, month, year. For example, for 3rd november, 1936 enter: "3.11.36" or "03.11.36"
(4): The age is calculated by the CARDIOVIT AT-6 on the basis of the date of birth (up to 2 years: number of months; up to 6 years: number of years and months; over 6 years: number of years)
(5): Sex: maximum length 13 characters
(6): Height in cm (3 figures)
(7): Weight in kg (3 figures)
(8): Blood pressure in mmHg (7 figures)
(9): Medication: maximum 16 characters
(10): Line for remarks: maximum length 22 characters

The cursor is located on the first parameter "Pat-Name". Enter the patient name and press **RETURN**. The cursor now moves automatically to the next line for the entry of the patient number. All entries are made in a similar way and each one must be confirmed by pressing **RETURN**.

Wrongly typed characters can be deleted with the **DEL** key. Whole lines can be typed over. The old contents of the line is deleted as soon as the first character is entered.

NOTE: If a new patient name is entered, all the other patient data and any ECG recording stored in the memory are automatically deleted.

Once all patient data has been entered and confirmed by pressing **RETURN**, press **FNCT** to return to the Monitor mode.

NOTE: When the Pulmonary Function option is installed, the patient data entered here will be retained when switching to the Pulmonary Function mode.

9. ACOUSTIC QRS INDICATION

The heart rate is indicated on the display as the average value of eight heart beats and in brackets as beat-to-beat extrapolation. By pressing key **Q**, the acoustic heart rate indication can be switched on and off.

10. CONNECTING THE PATIENT CABLE

The accessories kit of the electrocardiograph includes a 10-lead patient cable. This cable is plugged into the patient cable socket on the right-hand side of the unit and secured with the two screws.

The apparatus is CF (⊣♥⊢) rated. The patient connection is fully isolated and defibrillation protected. The unit can be used for intracardiac application. The protection against defibrillation voltage is only ensured, however, if the original Schiller patient cable is used.

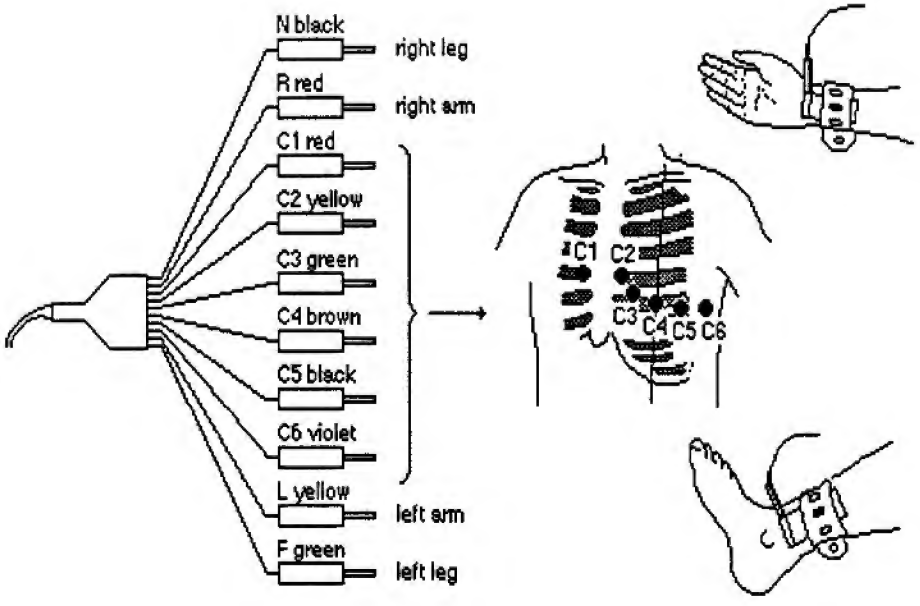
10.1 Connecting the Electrodes

The lower the resistance between skin surface and electrodes, the better the quality of the ECG recording. The skin areas have first to be cleaned with alcohol and thick hair has to be removed.

The standard accessories include four stainless steel limb electrodes and 6 precordial suction electrodes. The extremity electrodes are first spread with electrode gel and then fixed to the arm and foot pick-up points. Please make sure that the rubber bands are only tightened to such an extent as to prevent any movement of the electrode without constricting the blood circulation.

The precordial suction electrodes are also first moistened with gel and attached in their respective positions.

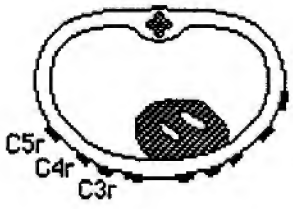
10.1.1 Standard leads I, II, III, aVR, aVL, aVF, V_1, V_2, V_3, V_4, V_5, V_6



10.1.2 Leads V3r, V4r, V5r

The electrodes have to be connected as follows:

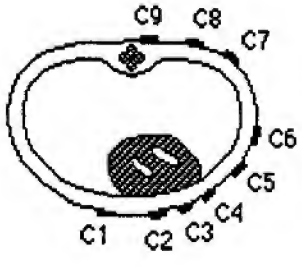
Plug C3 green to electrode C3r
Plug C4 brown to electrode C4r
Plug C5 black to electrode C5r



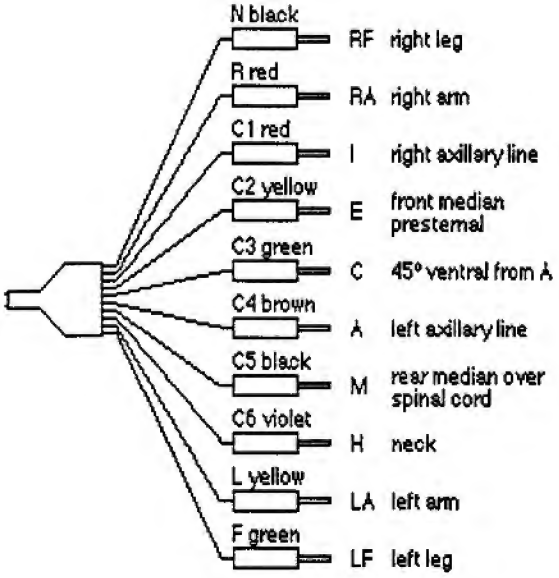
10.1.3 Leads V7, V8, V9

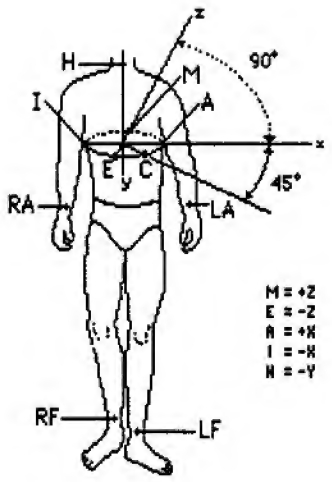
The electrodes have to be connected as follows:

Plug C1 red to electrode C7
Plug C2 yellow to electrode C8
Plug C3 green to electrode C9



10.1.4 Frank leads X, Y, Z

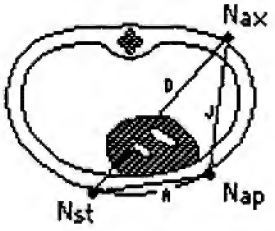




10.1.5 Nehb leads

The electrodes have to be connected as follows:

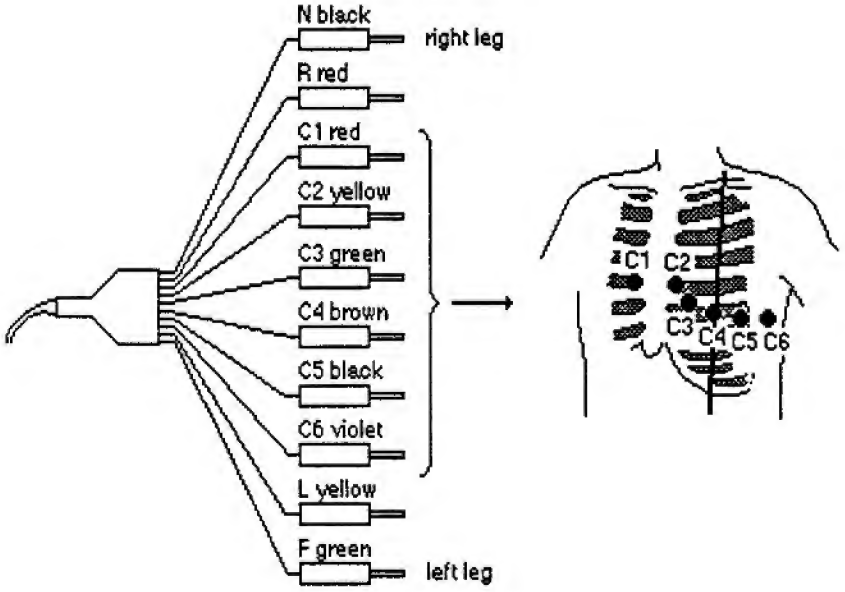
Plug R red to electrode on N_{st}
Plug L yellow to electrode on N_{ax}
Plug F green to electrode on N_{ap}
Plug N black to electrode on right leg



10.1.6 Bipolar leads CF_1 - CF_6

These leads are measured between one extremity electrode (F green) and the precordial electrodes C_1 - C_6. The electrode F green is usually placed on the left leg. In this way, the semithoracic leads CF_1 - CF_6 are derived.

The F electrode can also be placed in other positions: If it is placed on the manubrium of the sternum, you will derive CM leads.



Chapter 2

RECORDING RESTING ECGs

CONTENTS

1. INTRODUCTION

As soon as the patient is connected to the patient cable and the unit is switched on, the ECG is recorded and represented on the screen. At the same time, the heart rate (mean value and beat-to-beat), date and time as well as the leads shown are indicated. If an electrode is not properly connected, a warning to that effect is given on the display. This disturbance has to be removed before the ECG recording can take place.

During ECG recording, ensure that neither the patient nor the conducting parts of the patient connection or the electrodes (including the neutral electrode) come into contact with other persons or conducting objects, even if these are earthed.

There are two principle methods of recording ECG signals with the CARDIOVIT AT-6, namely Automatic and Manual. In Manual mode, the actual real-time ECG recording is stored for a period of 10 seconds in the input memory and is continually renewed. The number of leads, the lead group, chart speed and sensitivity can be freely selected. In Automatic mode, the ECG signals are transferred from the input memory to the working memory for further processing and averaging.

During recording, one or more recording parameters can be changed at any time. After each switching to a new lead group, the sensitivity is automatically adjusted and the respective 1mV calibration signal recorded. Whenever baseline drifts occur, the ECG is automatically centered again. In certain cases (eg when attaching an electrode or when an electrode becomes disconnected), the input signal could be momentarily much higher and therefore fall outside the normal range of the ECG amplifier. In such a case, the amplifier is automatically reset and this is indicated by a 50Hz square wave which replaces the normal trace for each of the 12 leads both on the screen and on the printout.

The selection of the display format is the same whether in Manual or Automatic mode, however the format selection for the printout differs.

2. SELECTING DISPLAY CONFIGURATION

2.1 Lead Selection

The number of leads, the lead group and the lead sequence which are to appear on the display can be freely selected.

Number of Leads: On the screen, either one or three leads can be shown. By pressing the key **0 1/3** on the alphanumeric keyboard you can change from one mode to the other.

Lead Group: The lead group is selected by means of keys **D<** and **F>**. The selected lead group is indicated at the bottom of the screen. In 3-channel mode, the groups are selected according to the following list: 000 (no selection made), I - III, aVR - aVF, V1 - V3, V4 - V6, PROG 1 (user programmable group), PROG 2 (user programmable group), XYZ.

For the 1-channel mode, first choose the lead group and then, by means of key **C**, the single lead.

NOTE: If the channel selection for the printout is set to 6-channel, then the lead group indication at the bottom of the screen will be for six leads (ie I - aVF), however for the screen representation either the first or second group of three can be selected. The lead identifications on the left-hand side of the screen indicate which leads are selected. Also, the XYZ lead group cannot be selected if the printout selection is set to 6-channel.

The user programmable leads (indicated PROG) can be defined as described in para. 3.2.

Lead Sequence: The lead sequence can be selected by pressing key **V** to call up the menu for Various Settings. The first entry in this menu shows the selected lead sequence, either STANDARD or CABRERA. This selection can be changed by pressing key **X**. Press **FNCT** to return to the Monitor mode.

2.2 Sensitivity Selection

The sensitivity of the screen presentation can be freely selected by means of keys **5**^{5}, **6**^{10}, **7**^{20} and **8**^{40}. With these keys, the sensitivity can be set to 5, 10, 20 or 40 mm/mV. Each time the sensitivity setting is changed, the calibration signal is given and is also indicated on the printout. The selected sensitivity is indicated at the bottom left of the screen. In 3-channel mode, the sensitivity is only half the selected value.

2.3 Speed Selection

The leads can be represented on the screen at a speed of either 25 or 50 mm/sec. Speed selection is made by means of keys **1**^{25} and **2**^{50}.

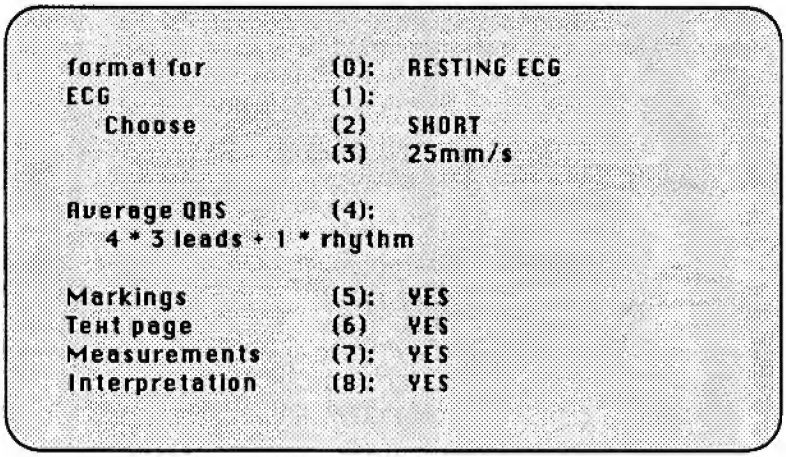
3. AUTOMATIC ECG RECORDING

When switching on, the unit is in Automatic mode. (To change from Manual mode to Automatic mode, press **COPY**.) For automatic processing, the ECG signals are taken from the input memory into the working memory. As soon as the **START** key is pressed, the last 10s of the current ECG recording are read into the working memory and after a short moment, the ECG is printed out in the selected format.

3.1 Printout Format in Automatic Mode

The format for the automatic ECG printout can be freely chosen. Usually, you will program the format only once when starting the CARDIOVIT AT-6 for the first time. Nevertheless, it is possible to change the programmed format at any time (some of the format options are valid only for M and C versions).

To make the format selections, press **A** and the following table appears on the screen:



Firstly select "RESTING ECG" by pressing key **0**.

In the **ECG section**, the format of the printed leads is determined by pressing key **1**. Several different formats are available as follows:

Entry **Output format:**

1 - - - - - - -
No leads are printed

4 * 3 leads + rhythm.
On 30 cm, all the 12 standard leads plus one rhythm strip (lead R1) are printed.

1 * 3/6 leads (10 s)
10s of the user programmed leads (see para. 3.2) are printed at a chart speed of 25 mm/s.

choose (2) SHORT
(3) 25 mm/s
12 leads are printed on 3 or 6 channels according to selection. The length of the recording is selected with key **2** as 'SHORT' (one page = 30 cm) or 'LONG' (two pages = 60 cm), the chart speed with key **3** (25, 50, or 100 mm/s).

In the **Average QRS** section, the format of the page with the average ECG cycles is selected (applies to M or C versions only). The changes are executed by pressing key **4** as follows:

Entry	Output format
4	**- - - - - - - - - -** No average cycles are printed.
	compact 1 The average complexes at a chart speed of 25 mm/s and one rhythm lead (R1) are printed. There is also place for patient data, interpretation (only version C) and measurement results.
	2 * 6 leads + 2 * Rhy On one page the average complexes and two rhythm leads over 10 s are printed at 25 mm/s.
	4 * 3 leads + 1 * Rhy The average complexes at a chart speed of 50 mm/s and one rhythm lead (R1) at 25 mm/s are printed.
	compact 2 2 x 6 average complexes plus one rhythm lead (R1) are printed out at a chart speed of 50mm/s. There is also place for patient data, interpretation (only version C) and measurement results.

Markings (only versions C and M):

5	**YES/NO** The reference markings (beginning and end of P wave and QRS as well as end of T wave) can be added to the ECG cycles (YES) or omitted (NO).

Text Page:

6	**YES/NO** The print-out of the text page containing all patient data and measurement results can be either enabled (YES) or suppressed (NO).

Measurements (only versions C and M):

7	**YES/NO** The detailed table of measurement results can be selected for printout (YES) or can be omitted (NO). The values of electrical axes, intervals, and heart rate are not suppressed when NO is selected. The table of measurements can only be printed if the printout consists of at least two standard pages of 30 cm.

Interpretation (only version C):

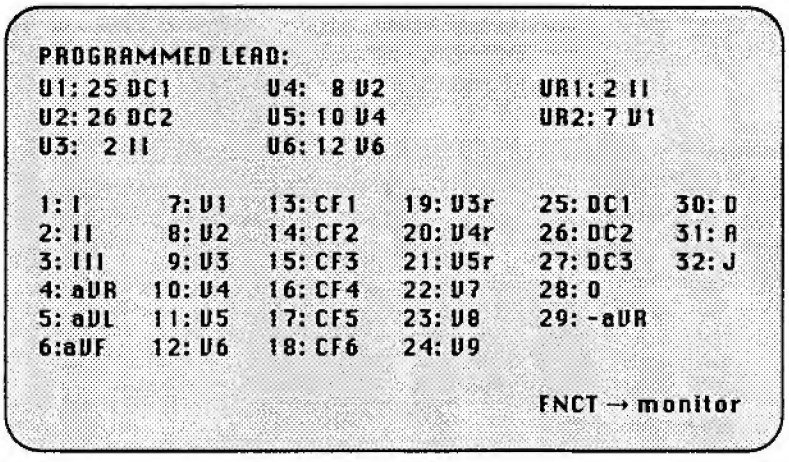
8	**YES/NO** The interpretation statements can be selected for printout (YES) or can be omitted (NO).

Once all selections have been made and the **START** key is pressed, the ECG is automatically printed in the selected format. If your CARDIOVIT AT-6 is equipped with software for ECG measurement and interpretation, then the average cycles, measurement results and interpretation statements will also be printed.

Beginning and end of the page are set to the perforation so that after the end, the ECG strip can be easily removed.

3.2 Selecting the User Programmable Leads

This function enables the user to select a unique lead group. Press **FNCT** to return to the Monitor mode and then press **L** to call up the following table:



The bottom part of the table comprises all the leads with a code (from 1 to 32) for each. The top part of the table indicates which leads are selected.

The cursor is on the input line U1. Choose the desired lead by entering the corresponding code (eg 8 for lead V2). Press **RETURN** to confirm the entry and the cursor moves to the next line for entry of the next code. Up to 6 leads can thus be freely selected which will be printed on six channels in Manual mode, or recorded, stored and printed out in Automatic mode.

In the right-hand column you can define the rhythm leads. These leads can only be selected from the standard leads 1 to 12 and 29. R1 is printed out if only one rhythm lead is selected in Automatic mode or in Rhythm mode. R1 and R2 are printed if two rhythm leads are selected.

NOTE: The rhythm leads cannot be displayed and can only be printed out in Automatic or Rhythm mode.

The user programmed leads can be stored in the base setting (see para. 7). Press **FNCT** to return to the Monitor mode.

3.3 Sensitivity in Automatic Mode

All leads are recorded with a sensitivity of 10 mm/mV, unless the amplitudes are too large in which case the sensitivity is automatically reduced to 5 mm/mV. The 1 mV calibration signal given at the beginning of each ECG tracing indicates the sensitivity applied.

In exceptional cases it is possible to change the sensitivity manually for copies of the stored ECG recording by selecting the new sensitivity before pressing the **COPY** key. The whole ECG is then printed out with the new sensitivity.

3.4 Copies of ECGs in Automatic Mode

Press the **COPY** key to print out once more the ECG from the memory. Each ECG can be copied as many times as you want.

The number of copies can be preselected (see Chapter 4, para. 2 *Various Settings*) so that each time the **START** key is pressed in Automatic mode the same number of copies is printed out. This presetting is useful if you always need the same number of ECG strips.

If you do not always require copies of the ECG, and the above setting is set to "0", a single copy can be produced by pressing the **COPY** key. As the original ECG signals are stored, you can print the ECG in different formats and with different contents by making the required changes (see para. 3.1) and then pressing **COPY**.

4. MANUAL ECG RECORDING

Press the **M** key in order to switch from Automatic to Manual mode for the real-time recording of ECG traces. At any specific event (e.g. an extrasystole), the ECG can be printed for further examination.

To produce a printout in Manual mode, press the **START** key and the three or six selected leads are printed. On the lower edge of the ECG strip the chart speed, sensitivity, indications of possible disturbances, heart rate, name of patient as well as the date and time of the recording are continually recorded.

Press the **STOP** key in order to interrupt the printout.

During the recording, you can change one or more recording parameters at any time. After each switching to a new lead group, a 1mV-calibration signal is recorded.

4.1 Printout Format in Manual Mode

In Manual mode, the number of leads, lead group, chart speed, and sensitivity can be freely chosen.

4.1.1 Lead Selection

Number of Leads: The number of printed leads is selected by pressing key **9 3/6** on the alphanumeric keyboard. The selection changes from 3 to 6 and back again. The setting you want to use normally can be stored in the base setting (see para. 7 *Base Setting*). The number of leads selected is indicated at the bottom of the screen.

Lead Group: The lead group is selected by means of keys **D<** and **F>**. The selected lead group is indicated at the bottom of the screen. In 3-channel mode, the groups are selected according to the following list: 000 (no selection made), I - III, aVR - aVF, V1 - V3, V4 - V6, PROG 1 (user programmable group), PROG 2 (user programmable group), XYZ.

NOTE: The XYZ lead group cannot be selected if the printout selection is set to 6-channel.

The user programmable leads (indicated PROG) can be defined as described in para. 3.2.

Lead Sequence: The lead sequence can be selected by pressing key **V** to call up the menu for Various Settings. The first entry in this menu shows the selected lead sequence, either STANDARD or CABRERA. This selection can be changed by pressing key **X**. Press **FNCT** to return to the Monitor mode.

4.1.2 Selecting Chart Speed

For the printout of the real-time recording in Manual mode, the chart speed can be selected by pressing the corresponding keys (**1**^{25}, **2**^{50}, **3**^{100} or **4**$^{+10}$). The last key divides the values of the preceding ones by 10, i.e. for a condensed strip of 5 mm/s you have to press keys 50 and +10. The selected chart speed is indicated on each ECG printout. To return to one of the main speed settings, press +10 once again.

4.1.3 Sensitivity Selection

The sensitivity for the printout can be freely selected by means of keys **5**^{5}, **6**^{10}, **7**^{20} and **8**^{40}. With these keys, the sensitivity can be set to 5, 10, 20 or 40 mm/mV. Each time the sensitivity setting is changed, the calibration signal is given on the screen and is also indicated on the printout. The selected sensitivity is indicated at the bottom left of the screen.

4.2 Copies of ECGs in Manual Mode

For copies of the manual ECG tracings or for a detailed analysis of a particular event, the last 10 seconds of the ECG can be stored in the working memory by pressing the **COPY** key. After a short moment, the ECG will be printed in the format selected for Automatic mode, see para. 3.1.

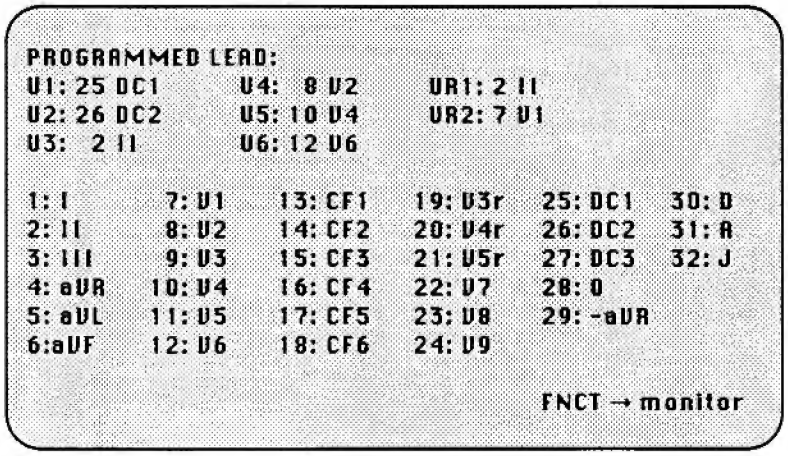
NOTE: The sensitivity can be altered by pressing key **5**^{5}, **6**^{10}, **7**^{20} or **8**^{40} before pressing the **COPY** key.

5. RECORDING OF LONG-TERM RHYTHM ECGS

This function enables pre-selected rhythm leads to be recorded and printed out in the required format. Before starting the rhythm recording, ensure that the required leads have been selected.

5.1 Selecting the Rhythm Leads

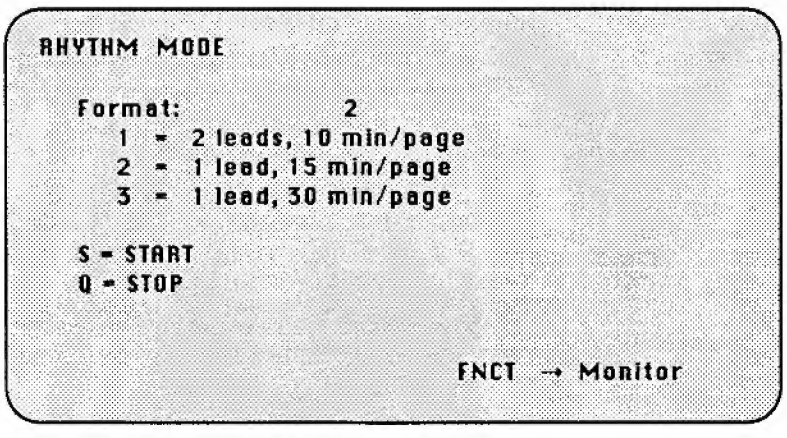
The rhythm leads can be freely selected by pressing **FNCT** to return to the Monitor mode and then pressing key **L** to call the following table to the display:



In the top right-hand column you can define the rhythm leads. These leads can only be selected from the standard leads 1 to 12 and 29. R1 is printed out if only one rhythm lead is selected in Rhythm mode, R1 and R2 are printed if two rhythm leads are selected. Press **FNCT** to return to the Monitor mode.

5.2 Selecting the Printout Format

By pressing key **R** when in the Monitor mode, the following table for selecting the format appears on the LC display:



A choice of three rhythm formats is available as follows:

1 = Printout of programmed leads R1 and R2 on one page (10 min. per page)
2 = Printout of programmed lead R1 on one page (15 min. per page)
3 = Printout of programmed lead R1 on one page (30 min. per page)

Above the list of format selections, the currently active selection is indicated. In the above example, format number 2 is selected.

5.3 Starting Rhythm Recording

Once all selections have been made, start rhythm recording by pressing key **S**. As soon as the rhythm recording is started, the indication "R" appears at the bottom right of the LC display.

NOTE: The following functions cannot be started during long-term rhythm recording:
- ECG recording
- RS-232 control
- Pulmonary function testing

The printout is started as soon as the information for one page is available, i.e. after 10, 15 or 30 minutes according to the format selected. If the recording is stopped before that time (by pressing **Q**), the rhythm leads are immediately printed out.

The patient identification and name, the printed leads, the chart speed, the date and the name of the user are printed on the lower margin of the paper.

Press **Q** to end rhythm recording. Press **FNCT** to return to the Monitor mode.

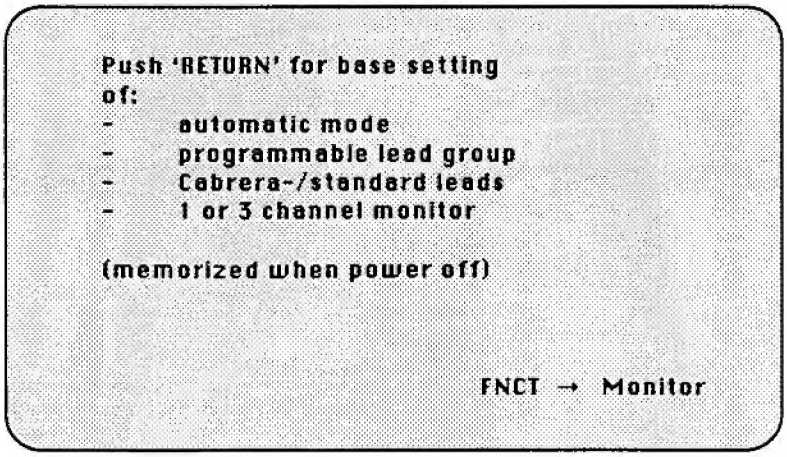
6. CALIBRATION

At any time during ECG recording, a 1mV calibration signal can be manually produced by pressing the **1mV** key. This 1mV signal is indicated both on the display and on the printout.

7. BASE SETTING

It is possible to establish a base setting for most of the programmable variables. Thus, your CARDIOVIT AT-6 is ready for you in exactly the right setting whenever you switch it on.

Press letter **G** to call up the base setting menu:



By pressing **RETURN**, the current selections made for automatic mode, programmable lead group, lead sequence and the display format are permanently stored as a base setting.

As soon as you switch on, all these parameters are preset. A change should only be necessary for exceptional cases.

Chapter 3

RECORDING EXERCISE ECGs

CONTENTS

1. INTRODUCTION

For the recording of exercise ECGs the CARDIOVIT AT-6 can be used in conjunction with either a bicycle ergometer or a treadmill with remote control. Once programmed, the exercise test procedure is automatically controlled from the CARDIOVIT AT-6. For optimal results, we recommend the use of a video monitor. For further information, refer to Chapter 7, Option 5: Video Monitor.

2. PREPARATION

2.1 Selecting the Ergometer

The first step in preparing the unit for exercise testing is to set the CARDIOVIT AT-6 to the type of ergometer to be used. In the monitor mode, press key **V** to call up the "Various Settings" menu. The sixth line on the first page of this menu reads "stress test". By pressing key **E**, the required ergometer setting can be selected. The choices available are as follows:

Bicycle ergometers:

- **BIKE:** This is the normal setting to be selected when working with all voltage controlled bicycle ergometers (1V corresponds to 100W).
- **BIKE RS232:** Select this setting when using a Dynavit M900 bicycle ergometer with serial interface.

Treadmills:

- **TMRS232:** This setting is to be selected when working with the SCHILLER R9 treadmill.
- **TM TRKM:** This setting should be selected when working with the Trackmaster treadmill.
- **TM POWJ:** This setting should be selected when working with the Powerjog M10S treadmill.

2.2 Connecting the Ergometer

The ergometer must be connected to the relevant socket on the connector panel on the right-hand side of the CARDIOVIT AT-6 and then to the mains supply.

For **bicycle ergometers** of the standard (analogue) type, the 5-pin plug is connected to the "ERGO" interface socket. Dynavit ergometers, depending on the cable supplied, can either be connected to channel B or 2 on the splitter box or connected directly to the "RS-232" serial interface on the AT-6. Adjust the height of both the saddle and the handlebars to correspond with the patient's physique.

For treadmills, the connection is made to channel B or 2 on the supplied splitter box and the splitter box connected to the "RS-232" serial interface on the AT-6.

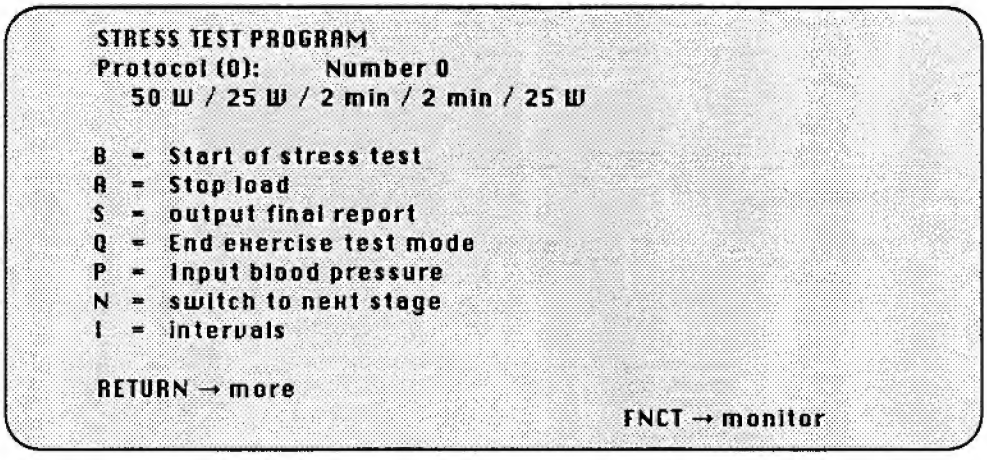
Once the ergometer has been connected to the AT-6 and switched on, attach the electrodes to the patient and connect the patient cable. Now enter the patient data (call up the menu by pressing key **P**).

Before starting an exercise test, a resting ECG should be recorded and a blood pressure measurement made to ensure that the patient is suitable for an exercise test and/or for comparison purposes.

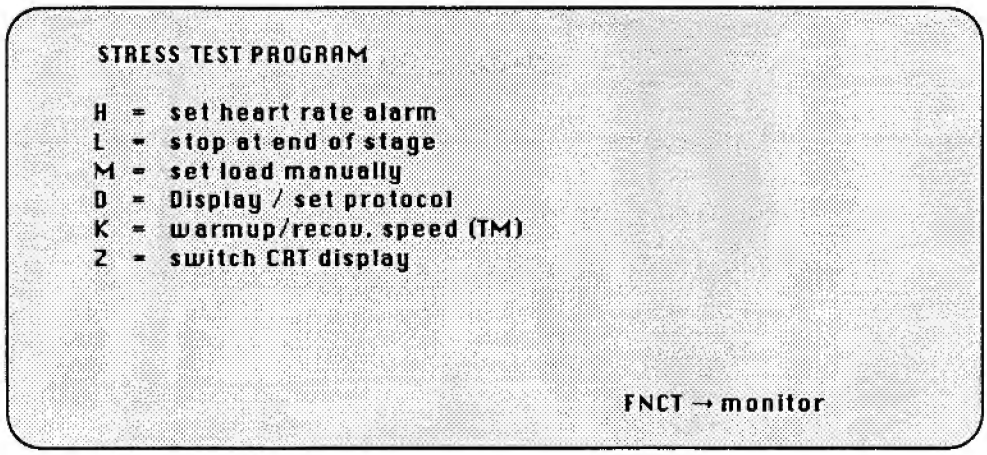
3. SETTINGS AND ADJUSTMENTS BEFORE THE TEST

3.1 Calling up the Exercise Test Program

Before starting the test, certain parameters and settings may need to be selected. When in the monitor mode, press key **E** to call up the Stress Test program and the first page of the menu is displayed as follows:



By pressing **RETURN** you can move on to the second page as follows:

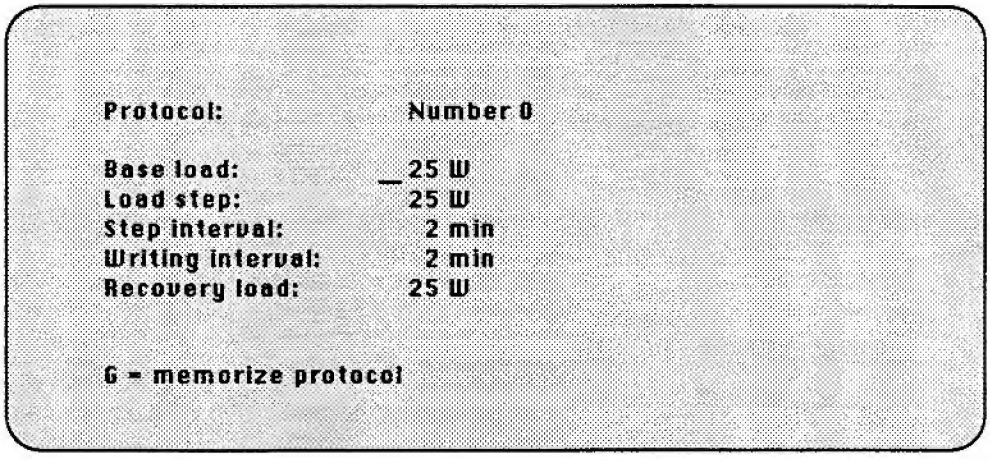


3.2 Selecting the Bicycle Test Protocol

At the top of the first page of the Stress Test menu the currently selected Protocol is indicated together with a summary of the selected values. The values indicated represent from left to right:

Base load / Load step / Step duration / Writing interval / Resting load

There are four user-programmable protocols available, numbered 0 to 3. To select the required protocol, press key **0**. To view the selected protocol in detail or to alter any of the parameters, press key **D** and the selected protocol will be displayed as in the following example:



The cursor is ready on the first line **base load**. This is the load which will be applied at the start of the test. To alter the current value, simply type in the value required (steps of 5 W) and press **RETURN** to confirm the entry. The cursor now moves down to the load step value.

The **load step** determines the load increase for each step. To alter the current value, simply type in the value required (steps of 5 W) and press **RETURN** to confirm the entry. The cursor now moves down to the step interval.

NOTE: Depending on the type of ergometer, the exercise test will continue to apply load steps (unless manually interrupted) up to a maximum load of between 300 and 500 W.

The **step interval** determines the length of time a load step is maintained before moving on to the next one. To alter the current interval, simply type in the value required and press **RETURN** to confirm the entry. The cursor now moves down to the writing interval.

The **writing interval** indicates the intervals at which the periodic 12-lead ECG recording is printed out. To alter the current time interval, simply type in the value required and press **RETURN** to confirm the entry. If no periodic printout is required, type in a zero. The cursor now moves down to the recovery load.

The **recovery load** is the load which will be imposed during the 2-minute recovery phase to which the ergometer returns as soon as the exercise test is interrupted. To define this load, you can either enter the load you require or programme the unit to automatically impose a predetermined load by entering 99. In the latter case, the resting load is dependent upon the maximum working load as follows:

Max. working load	Resting load
> 150 W	50 W
150 W or less	25 W

Once all the required settings have been made, the complete protocol can be stored in the base settings (see Chapter 2, para. 7) by pressing key **G**. The protocol will then be retained, even when the CARDIOVIT AT-6 is switched off, and will be available the next time the exercise test programme is called up with one of the bicycle settings selected in the menu "Various settings" (see para. 2.1).

Press **FNCT** to return to the main Exercise Test menu.

The above settings can be made for each of the four available protocols by first selecting the protocol number in the main Exercise Test menu by means of key **0** and then pressing key **D** to display the protocol settings as shown above.

3.3 Selecting the Treadmill Test Protocol

At the top of the first page of the main Exercise Test menu the currently selected Protocol is indicated together with its name. There are five preprogrammed (0 to 4) and five user-programmable (5 to 9) protocols available.

To select the required protocol, press key **0**. To view the selected protocol in detail, press key **D** and the selected protocol will be displayed. To move on to the next protocol, press key **X**.

The five **preprogrammed protocols** are as follows:

PROTOCOL No 0 (BRUCE):

STAGE	DUR.	SPEED	GRADE
1	3 min	2.7 km/h	10.0 %
2	3 min	4.0 km/h	12.0 %
3	3 min	5.4 km/h	14.0 %
4	3 min	6.7 km/h	16.0 %
5	3 min	8.0 km/h	18.0 %
6	3 min	8.8 km/h	20.0 %
7	3 min	9.6 km/h	22.0 %

PROTOCOL No 1 (BALKE)

STAGE	DUR.	SPEED	GRADE
1	2 min	5.0 km/h	2.5 %
2	2 min	5.0 km/h	5.0 %
3	2 min	5.0 km/h	7.5 %
4	2 min	5.0 km/h	10.0 %
5	2 min	5.0 km/h	12.5 %
6	2 min	5.0 km/h	15.0 %
7	2 min	5.0 km/h	17.5 %
8	2 min	5.0 km/h	20.0 %
9	2 min	5.0 km/h	22.5 %
10	2 min	5.0 km/h	25.0 %

PROTOCOL No 2 (NAUGHTON)

STAGE	DUR.	SPEED	GRADE
1	3 min	3.0 km/h	0.0 %
2	3 min	3.0 km/h	3.5 %
3	3 min	3.0 km/h	7.0 %
4	3 min	3.0 km/h	10.5 %
5	3 min	3.0 km/h	14.0 %
6	3 min	3.0 km/h	17.5 %

PROTOCOL No 3 (ELLESTAD)

STAGE	DUR.	SPEED	GRADE
1	3 min	2.7 km/h	10.0 %
2	3 min	4.8 km/h	10.0 %
3	3 min	6.4 km/h	10.0 %
4	3 min	8.0 km/h	10.0 %
5	3 min	8.0 km/h	15.0 %
6	3 min	9.6 km/h	15.0 %

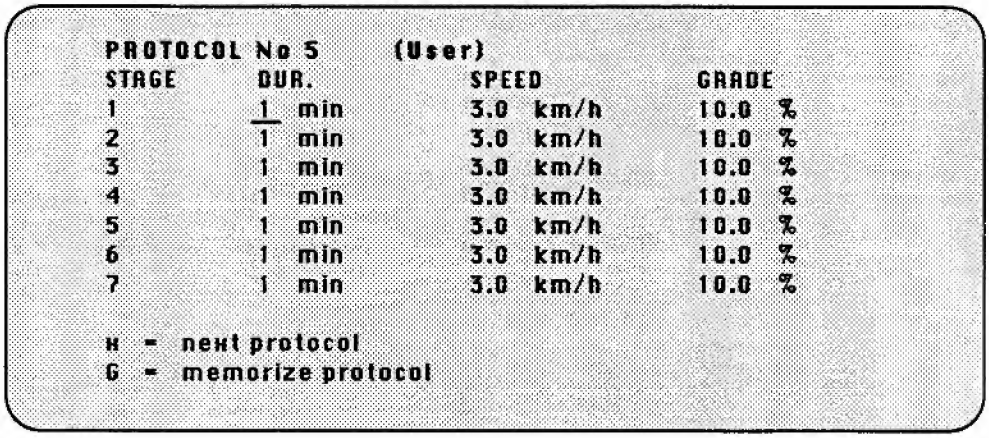
PROTOCOLNo 4 (COOPER)

STAGE	DUR.	SPEED	GRADE
1	1 min	5.3 km/h	0.0 %
2	1 min	5.3 km/h	2.0 %
3	1 min	5.3 km/h	3.0 %
4	1 min	5.3 km/h	4.0 %
5	1 min	5.3 km/h	5.0 %
6	1 min	5.3 km/h	6.0 %
7	1 min	5.3 km/h	7.0 %
8	1 min	5.3 km/h	8.0 %
9	1 min	5.3 km/h	9.0 %
10	1 min	5.3 km/h	10.0 %

Each of the five **user programmable** protocols can be viewed in the same way, and can be programmed to suit user requirements.

The duration, speed and grade can be altered as required but the stages are preset. The first four user programmable protocols (numbers 5 to 8) have 7 stages, the last one (number 9) has 10 stages.

When one of these protocols is displayed, the cursor is ready on the first duration as in the following example:



The **duration** is the length of time a stage is maintained before moving on to the next one. To alter the current duration time, simply type in the value required and press **RETURN** to confirm the entry. The cursor now moves down to the next duration. Once all duration times have been entered, the cursor moves over to the first entry in the speed column.

The **speed** entries determine the speed (up to a maximum of 25 km/h) maintained for each stage. When all speed entries have been made, the cursor moves over to the first entry in the grade column.

The **grade** entries determine the elevation (up to a maximum of 25%) of the treadmill for each stage.

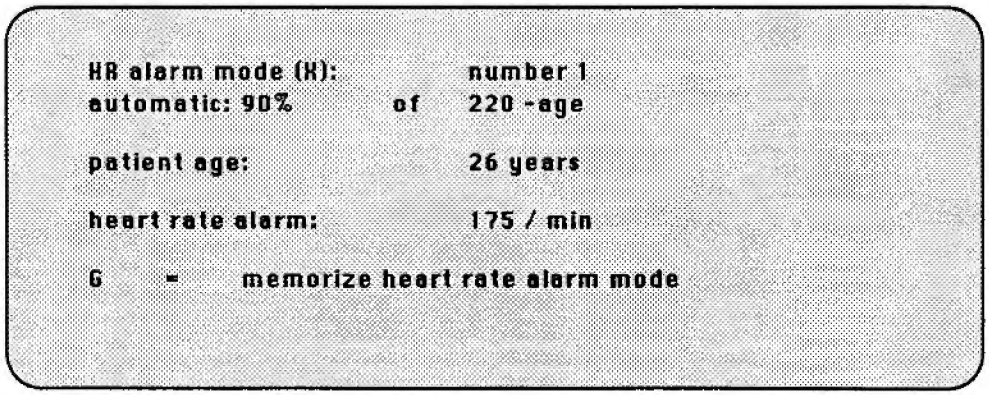
NOTE: If it is only required to alter specific entries in the protocol, the cursor can be moved to the required position by means of keys **R** (up), **D** (left), **F** (right) and **C** (down).

Once all the required settings have been made, the complete protocol can be stored in the base settings (see Chapter 2, para. 7) by pressing key **G**. The protocol will then be retained, even when the CARDIO-VIT AT-6 is switched off, and will be available the next time the Exercise Test programme is called up with one of the treadmill settings selected in the menu "Various settings" (see para. 2.1).

Press **FNCT** to return to the monitor mode.

3.4 Setting the Heart Rate Alarm

Before each test, the heart rate limit has to be set. This setting enables the automatic initiation of an acoustic alarm as soon as the heart rate limit is reached during the course of the exercise test. When in the main Exercise Test menu, press key **H** to call up the heart rate input menu as follows:



There are four automatic calculations (numbered 0 to 3) available and one setting (number 4) for manual input of the heart rate limit.

With the automatic calculations, the patient age is taken from the patient data and the point of initiation of the heart rate alarm is calculated accordingly.

With the manual entry, the heart rate alarm limit is entered by the user. To select the required calculation or to select the manual input, press key **X**.

The available automatic calculations are as follows:

No 0: **220 -age** (220 minus patient age)

No 1: **90 % of 220 -age** (90% of 220 minus patient age)

No 2: **200 -age** (200 minus patient age)

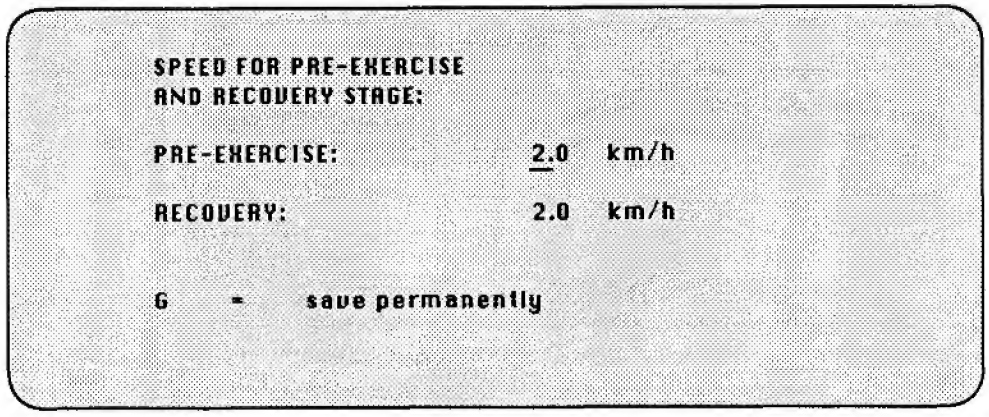
No 3: **male:** **205 -1/2 age** (205 minus half the patient's age)
female: **220 -age** (220 minus patient age)

The selected formula, or the manual entry, can be memorized as base setting by pressing **G**. For the next test, this setting will be active.

Press **FNCT** to return to the main Exercise Test menu.

3.5 Warm-up / Recovery Speed

When conducting an exercise test with a treadmill, the speed for the warm-up (pre-exercise) and recovery stages can be manually set. Press key **K** to call up this sub-menu as follows:



The cursor is ready for the entry of the pre-exercise speed. Enter the desired value and press the **RETURN** key to confirm the entry. Now enter the required speed for the recovery phase at the end of the test and press **RETURN** to confirm the entry.

To store the entries made, press **G** and these speeds will be available each time exercise testing is called up with a treadmill.

NOTE: These speed settings can only be made for exercise tests with a treadmill. When a treadmill setting has not been selected (see para. 2.1), then the speed settings sub-menu is inactive.

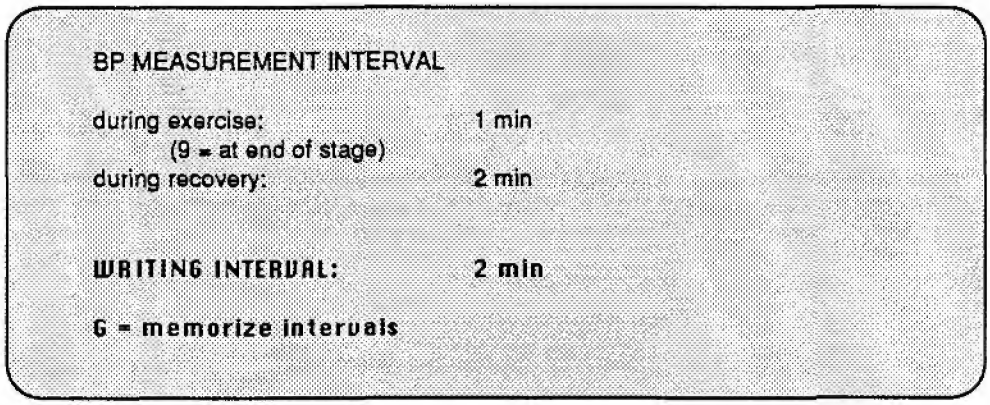
Press **FNCT** to return to the monitor mode.

3.6 Interval for Periodic ECG Printout

For the periodic ECG printout, it is possible to set the intervals at which the printout will be made as well as the format and content.

For exercise tests with a bicycle ergometer, the interval is selected in the "Protocol" menu and can be set separately for each protocol (see para. 3.2).

To set the periodic printout interval for tests with a treadmill, press key **I** when in the main Exercise Test menu to call up the Intervals menu as follows:

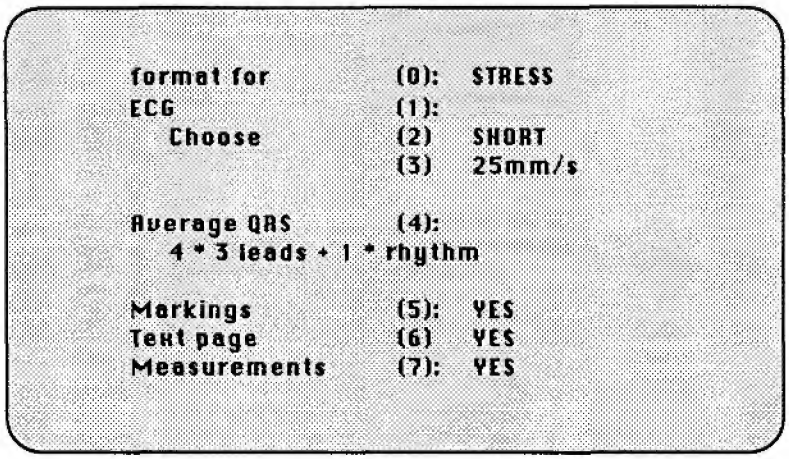


The third input line is that for the "writing interval". Press the **RETURN** key until the cursor is on this line and enter the desired value ie, the number of minutes between printouts. If no periodic printout is required, type in a zero. Once entered, the value can be stored as a base setting by pressing key **G**.

Press **FNCT** to return to the monitor mode.

3.7 Format for Periodic ECG Printout

The ECG format and content of the printout are selected in the menu "Format for Automatic Mode". To enter this menu, press **FNCT** to return to the monitor mode, press key **A** and the following table appears on the screen:



The first line of the menu indicates whether resting or exercise ECG recording is to be carried out. Make sure that "STRESS" is indicated here by pressing key **0**. The format for the exercise test printout can now be defined as follows:

In the **ECG section**, the format of the printed leads is determined by pressing key **1**. Several different formats are available as follows:

Entry **Output format:**

1 **- - - - - - -**
No leads are printed

4 * 3 leads + rhythm.
On 30 cm, all the 12 standard leads plus one rhythm strip (lead R1) are printed.

1 * 3/6 leads (10 s)
10s of the user programmed leads (see para. 3.2) are printed at a chart speed of 25 mm/s.

choose (2) SHORT
(3) 25 mm/s
12 leads are printed on 3 or 6 channels according to selection. The length of the recording is selected with key **2** as 'SHORT' (one page = 30 cm) or 'LONG' (two pages = 60 cm), the chart speed with key **3** (25, 50, or 100 mm/s).

In the **Average QRS** section, the format of the page with the average ECG cycles is selected (applies to M or C versions only). The changes are executed by pressing key **4** as follows:

4 **- - - - - - - - - -**
No average cycles are printed.

compact 1
The average complexes at a chart speed of 25 mm/s and one rhythm lead (R1) are printed. There is also place for patient data, interpretation (only version C) and measurement results.

2 * 6 leads + 2 * Rhy
On one page the average complexes and two rhythm leads over 10 s are printed at 25 mm/s.

4 * 3 leads + 1 * Rhy
The average complexes at a chart speed of 50 mm/s and one rhythm lead (R1) at 25 mm/s are printed.

compact 2
2 x 6 average complexes plus one rhythm lead (R1) are printed out at a chart speed of 50mm/s. There is also place for patient data, interpretation (only version C) and measurement results.

Markings (only versions C and M):

5 **YES/NO**
The reference markings (beginning and end of P wave and QRS as well as end of T wave) can be added to the ECG cycles (YES) or omitted (NO).

Text Page:

6 **YES/NO**
The print-out of the text page containing all patient data and measurement results can be either enabled (YES) or suppressed (NO).

Measurements (only versions C and M):

7 **YES/NO**
The detailed table of measurement results can be selected for printout (YES) or can be omitted (NO). The values of electrical axes, intervals, and heart rate are not suppressed when NO is selected.

Once all selections have been, press **FNCT** to return to the monitor mode.

4. STARTING EXERCISE TESTING

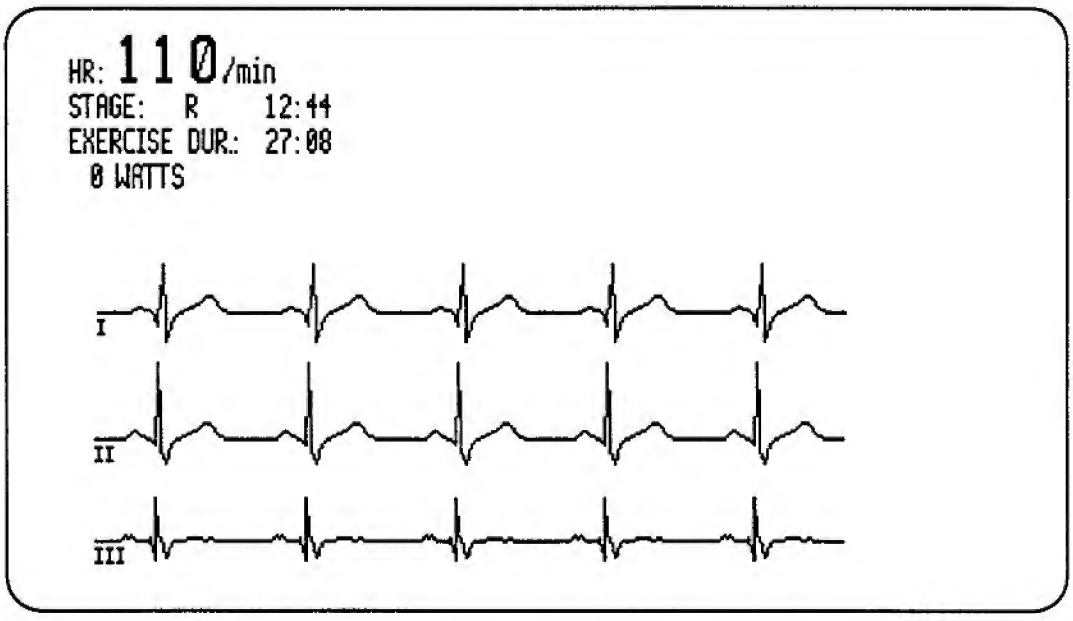
The exercise test is started by pressing key **B.** At first there is a pre-exercise phase, during which a resting ECG is recorded for comparison purposes. During this phase, the patient should sit or stand quite relaxed. After a minute the first load stage is initiated.

During the test, information regarding the stage, the applied load or the speed and elevation are continually displayed together with the test and stage duration.

At the pre-set intervals, a complete ECG will be printed out. The standard printout comprises two A4 pages containing the ECG traces and average cycles as preselected, as well as information concerning the progress of the test.

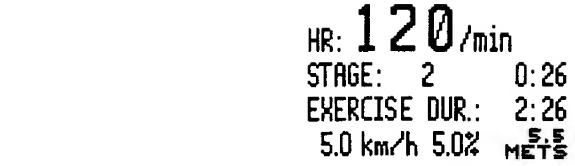
4.1 Displayed Information

The information displayed on the video monitor differs from that shown on the AT-6 screen and is more comprehensive. On the AT-6 screen, the recorded blood pressure, the stage identification, the load or speed and elevation as well as the duration of the test are continually displayed. However, when the main Exercise Test menu or a sub-menu is selected, the ECG traces are no longer visible. On the video monitor, the ECG traces will continue to be displayed even when a menu is selected on the AT-6. The display on the video monitor is as in the following example for a test with a bicycle ergometer:



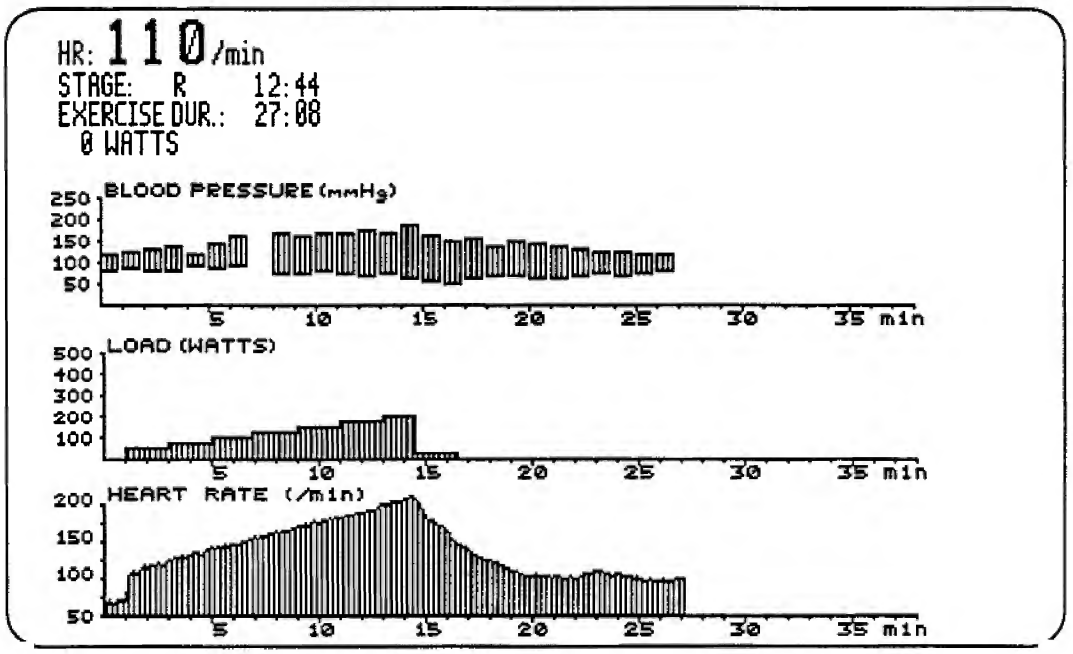
In the upper left of the screen, the heart rate, stage identification and duration, the total duration of the test and the load are displayed and continually updated. Below this information, the ECG traces are continuously displayed together with their lead identifications.

For tests with a treadmill, the information block in the top left of the screen is given as follows:



Here, the treadmill speed and elevation are given together with the metabolic equivalents (METS) for the current stage (see para. 4.1.1).

A further possibility with a video monitor is to switch the display to give trend plot diagrams for blood pressure, load (or speed and elevation), and heart rate. To display the trend plots, press key **Z** and the trends are displayed as in the following example:



To return to the ECG representation, press key **Z** once again.

4.1.1 Metabolic Equivalents (METS)

The metabolic equivalents, or METS, provide a simple means of determining energy expenditure during exercise. One MET is defined as the resting metabolic rate, ie the amount of oxygen consumed when seated at rest. Thus, an individual exercising at 2 METS requires twice the resting metabolism, and at three METS requires three times the resting metabolism. The provision of a MET value for each stage of an exercise test assists in determining the exercise tolerance of a patient in conjunction with factors such as weight, degree of fitness, sex and age.

4.2 Documented Information

The periodic printout comprises three sections, the first of which gives the ECG traces and the second shows the average cycles in accordance with the pre-selected format. The patient data; heart rate; QRS amplitude and axis; blood pressure systolic and diastolic values; ST amplitudes, integral and slope and the exercise test data are printed out on the third section. The exercise test data comprises the load (or speed and elevation), the stage identification and duration as well as the total duration of the test. For tests with a treadmill, the metabolic equivalents (METS) are also given. The patient name and number as well as the date and time of the recording are provided on each section of the printout.

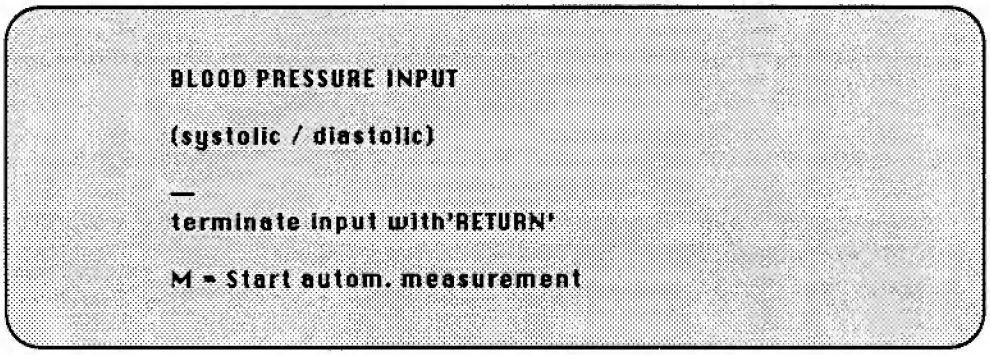
Should you require more printouts than has been preset, or if the writing interval has been set to 0, a printout can be manually initiated at any time during the test by pressing **START**.

5. SETTINGS AND ADJUSTMENTS DURING THE TEST

There are several adjustments and settings which need not be made before starting an exercise test but which can be made during the course of the test. These include blood pressure measurement settings and manual ergometer control which are described below.

5.1 Manual Blood Pressure Measurement

If separate blood pressure measurements are made independently of the electrocardiograph and the ergometer, then the results can be manually entered. It is also possible to manually initiate automatic blood pressure measurements. In the main Exercise Test menu, press key **P** to call up the Blood Pressure Input menu as follows:



The cursor is ready for the entry of the systolic and diastolic values. Confirm the entry by pressing **RETURN**. The information entered will appear both on the video monitor and on the periodic ECG printout.

NOTE: Each entered value remains available for a period of two minutes.

When in this menu, an automatic blood pressure measurement can be manually initiated at any time during the test by pressing key **M**.

Press **FNCT** to return to the main Exercise Test menu.

5.2 Automatic Blood Pressure Measurement

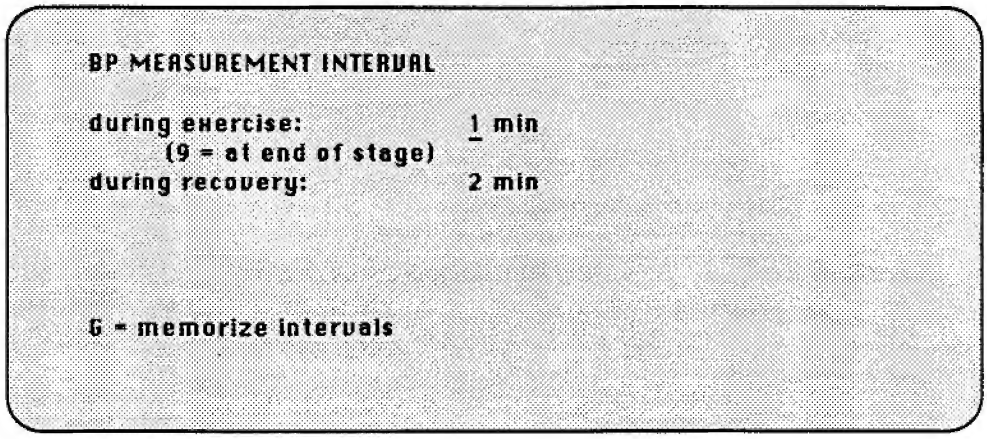
In order to carry out automatic blood pressure measurements during exercise testing, a suitable unit has to be connected to the CARDIOVIT AT-6. This is done by connecting the blood pressure measuring unit to channel A or 1 on the splitter box which in turn is connected to the RS-232 interface on the connector panel on the right-hand side of the CARDIOVIT AT-6.

Once connected, the measuring unit used has to be selected in the menu "Various Machine Settings". When in monitor mode, press key **V** to call the menu to the display and press key **P** to select the required unit. The choices available are as follows:

- - - - - - - - -	=	No unit selected
TONOPRINT	=	Tonoprint from Speidel & Keller
EBM 502	=	Model EBM 502 from Bosch and Ergoline 900

Once the relevant measuring unit has been selected, press **FNCT** to return to the monitor mode.

The next stage is to set the intervals between automatic measurements. To do this, select the Exercise Test main menu by pressing **E** and then press key **I** to call up the Intervals menu as follows:



The cursor is located in the position for the entry of the measurement intervals during the exercise test. Enter the required value and press **RETURN**.

NOTE: To obtain a blood pressure measurement at the end of each load stage, enter 9.

The cursor moves to the next line for the entry of the measurement interval during the recovery phase. Enter the required value and press **RETURN**. The CARDIOVIT AT-6 will now automatically initiate regular blood pressure measurements at the preset intervals throughout the course of the exercise test.

The measurement results are given on the periodic ECG printout and on the video monitor. In the final report, the measurement results are represented as a diagram.

NOTE: Each measurement result remains available for a period of two minutes.

Press **FNCT** to return to the monitor mode.

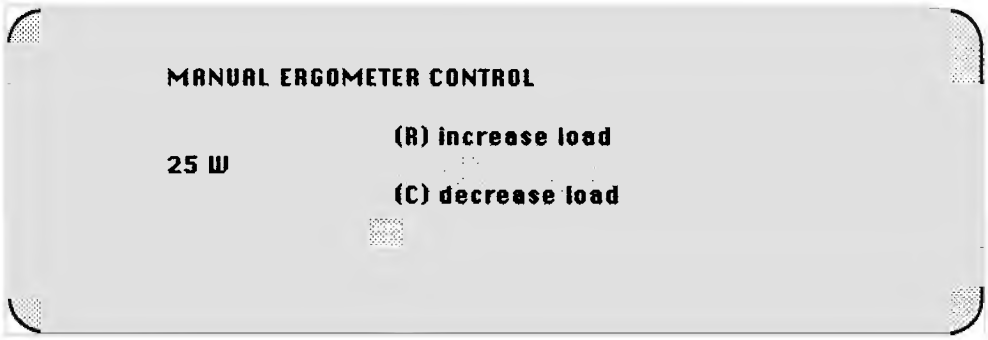
5.3 Manual Ergometer Control

During the course of the test, it is possible to manually manipulate the ergometer and/or the test procedure.

5.3.1 Bicycle ergometer

At any time during the test, the load step can be advanced by pressing key **N** and the load immediately changes to the next load step. This can only be done however, after the first 30 seconds of the pre-exercise phase have elapsed.

The course of the test can be changed totally by manually increasing or decreasing the load. In the main ExerciseTest menu, press key **M** and the following appears on the screen:



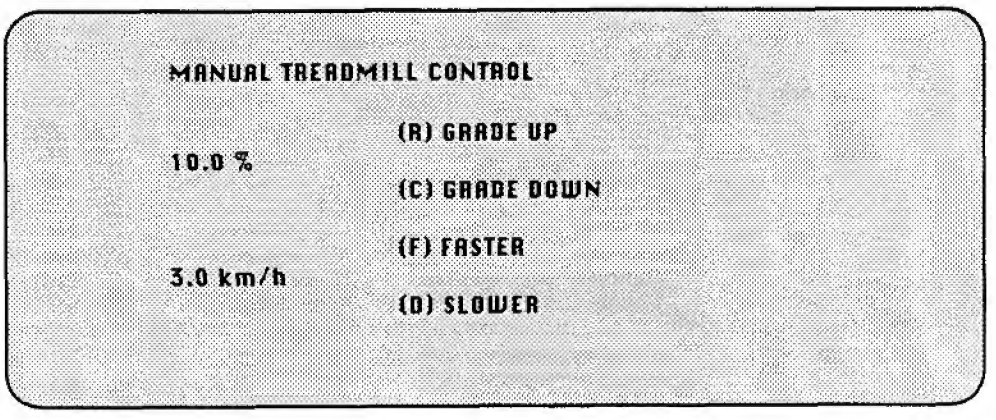
The current load is indicated on the left. By pressing key **R** the indicated load can be increased in steps of 5W up to a maximum of 500W. With key **C** the load can be decreased in steps of 5W. Once the desired load value has been selected, press **RETURN** and the selected load will be implemented.

Press **FNCT** to return to the main Exercise Test menu.

5.3.2 Treadmill

At any time during the test, the treadmill setting can be advanced to the next stage by pressing key **N**. This can only be done however, after the first 30 seconds of the pre-exercise phase have elapsed.

The course of the test can be changed totally by manually increasing or decreasing the treadmill elevation (Grade) and/or speed. In the main Exercise Test menu, press key **M** and the following appears on the screen:



The current elevation and speed are indicated on the left. By pressing key **R** the indicated elevation can be increased in steps of 0.5% up to a maximum of 25%. With key **C** the elevation can be decreased in steps of 0.5%.

With key **F**, the indicated speed can be increased in steps of 0.1km/h up to a maximum of 25km/h. By pressing key **D** the speed can be decreased in steps of 0.1 km/h.

Once the desired values have been selected, press **RETURN** and the selected elevation and/or speed will be implemented.

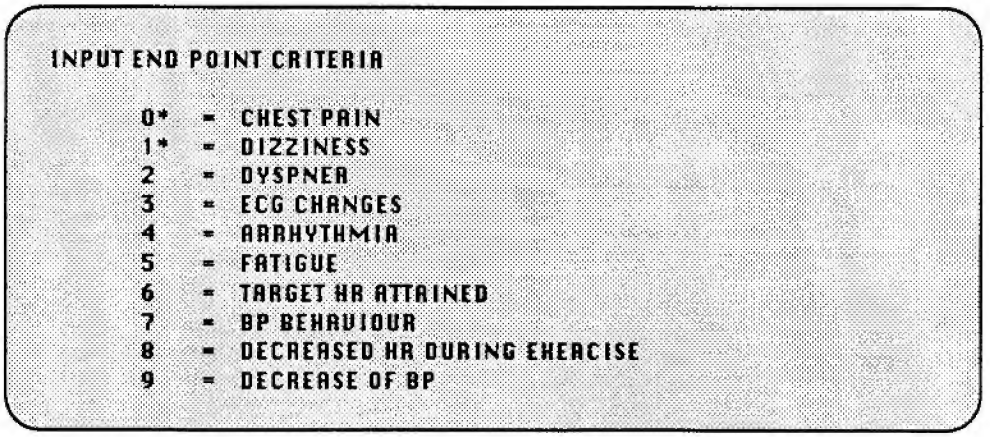
Press **FNCT** to return to the main Exercise Test menu.

6. INTERRUPTING EXERCISE TESTING

As soon as a criterion for interruption is reached, there are two possibilities to interrupt the exercise test.

With key **A**, the test is interrupted at once and a "PEAK EXERCISE" print-out is initiated. With key **L**, the test is interrupted at the end of the current load stage. In both cases, the load returns to the programmed recovery phase load. This programmed recovery load can be reduced to 0.0km/h by pressing key **A** once again.

The following criteria for interruption are then displayed:



Press the corresponding numbers to indicate the causes for interruption and the selected criteria are indicated with an asterisk. Once the required interruption criteria have been selected (maximum 2), press **RETURN** and the main Exercise Test menu returns to the display.

7. PRINTOUT OF FINAL REPORT

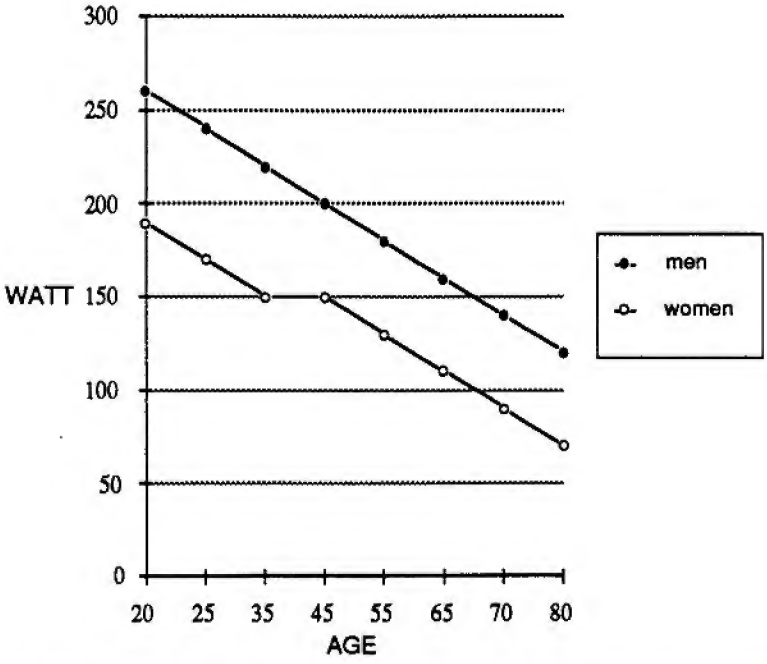
After interrupting the exercise test, the heart rate and blood pressure measurements continue. To produce a printout of the final report, press key **S** and, once the recovery phase is completed, the final report will be printed out.

7.1 Final Report for Bicycle Ergometer

All information resulting from the test is documented on the final report as follows:
- trendplots of blood pressure, heart rate and load
- the patient data
- the MTA identification and the date and time of the report
- the base load, load step and step interval
- the total duration at the end of the exercise period and the total duration at the end of the test
- the criteria for interruption
- the maximum heart rate achieved and the the percentage of maximum heart rate derived from the value set for the heart rate alarm
- the physical working capacities (PWC max., PWC 150 / 170, PWC rel.)
- the maximum blood pressure achieved and the maximum blood pressure (systolic) as a function of the heart rate.

The PWC (physical working capacity) value is an indicator of the physical working capacity at a specific heart rate. The following is an explanation of the PWC values given on the final report:

PWC max. - The maximum load in Watts achieved by the patient. There are statistics concerning the normal values of PWC max as a function of age and sex according to the following diagram (Bühlmann and Wahlund):



Relating the actual PWC max to this normal value gives a percentage value of the relative physical performance of the patient.

PWC 150/170 - The physical working capacity of the patient for a heart rate of 150/min and 170/min. With the assumption that there is a linear relationship between work load and heart rate, those values may be calculated based on the measured heart rate at the end of the last load stage and the measured heart rate at the end of the previous load stage. PWC 150/170 is given in Watts and can only be calculated when there is an increase in heart rate between the last two load steps of the test. Otherwise the value is not indicated.

PWC rel - The values of PWC 150/170 are divided by the weight of the patient giving an indication of the physical capacity related to the patient's body mass. The normal values for the relative PWC 170 are:

Males: 3W/kg (± 0.5W/kg)
Females: 2.4W/kg (± 0.5W/kg)

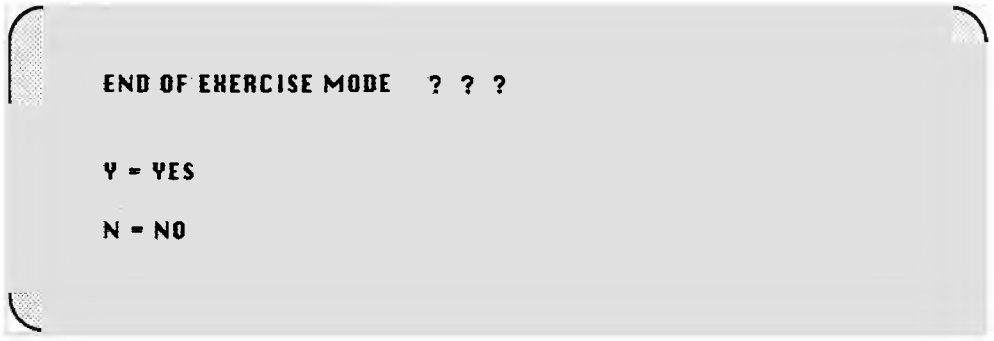
7.2 Final Report for Treadmill

All information resulting from the test is documented on the final report as follows:
- trendplots of blood pressure, heart rate and speed / elevation
- the patient data
- the MTA identification and the date and time of the report
- the protocol identification
- the total duration at the start of the recovery phase and the total duration at the end of the test
- the criteria for interruption
- the maximum heart rate achieved and the percentage of maximum heart rate derived from the value set for the heart rate alarm
- the maximum METS achieved
- the maximum blood pressure achieved and the maximum blood pressure (systolic) as a function of the heart rate.

8. QUITTING THE EXERCISE TEST MODE

To exit the exercise testing mode, press key **Q**.

If this is done before the test has run its full course, or without pressing key **S** to finish the test, the following question then appears on the display:



Press **Y** in order to quit the exercise test mode or **N** in order to return to the current test.

Chapter 4

FURTHER SETTINGS AND PROGRAMMES

CONTENTS

1. LONG-TERM MEMORY

In the long-term memory you can store approx. 20 ECGs. However, the data will remain available only until the CARDIOVIT AT-6 is switched off. The entire ECG data are stored together with the results from measurement and interpretation, patient data, date and time of the recording. The number of stored ECGs depends on the selected compression level.

The ECGs can be filed in the memory, called up and deleted. It is possible to have a list of the stored ECGs on the screen (indication of recording date and patient name) or call up the entire patient data of an ECG.

1.1 Organization of the Memory

In order to simplify access to the individual ECGs, the memory has been organized into pages and files. There are a total of three pages (numbered 0 to 2) and each page has a total of 10 files (numbered 0 to 9). Each ECG is thus defined by page and file number.

1.2 Data Compression

The number of ECGs stored depends on the extent of the ECG data memorized. By compressing the data within a specific tolerance range, the quantity of data is reduced without any loss of important information.

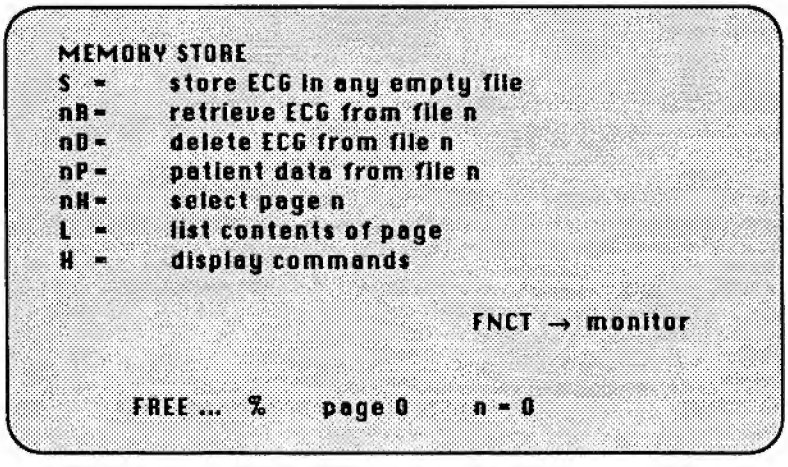
The compression level is set under 'Various Settings' (see para. 2.4). The larger the tolerance range, the greater the possible deviation from the original data, but also the smaller the amount of data to be stored. Even at a compression level of 30µV, the ECG will not be changed considerably.

NOTE: At a compression level of 5µV, it is possible that storage of the ECG will be inhibited in the event of heavy muscle tremor while the compression level set is not sufficient to suppress the signal deflections produced by the tremor. Please set a larger tolerance level and redo the recording.

The results of analysis and interpretation always refer to the original data.

1.3 Calling up the Memory Program

The memory program is activated by pressing key **Z** when in the Monitor mode and the following table is displayed:



S store ECG in any empty file

Press key **S** to file an ECG from the input memory to the long-term memory: The ECG is stored in the first empty space. The procedure will be acoustically confirmed. On the bottom of the display, the following indication appears.

ECG is stored now
FREE ... % page 0 n = 0

Apart from a confirmation of the successful storage, the last line indicates the remaining empty space, on which page, and in which file the ECG has been stored. The letter S on the right-hand side confirms the command executed.

nX select page n

For the following commands it is important to work with the correct page. As mentioned above, the ECGs on a page are defined by the number of the storage place (0 - 9). To get page 1, you have to enter the command "1X".

Acknowledgement: page 1 1X

L list contents of page

After pressing **L** you can see a list of all stored ECGs of the selected page (date, time and patient name). The following three commands are now made easy:

nR retrieve ECG from file n

In order to copy an ECG from the long-term memory to the working memory, you type "nR" (n has to be a number between 0 and 9 and marks the storage place of the ECG).

The correct execution of this command will be confirmed with an acoustic signal and you see on the screen:

ECG read correctly
FREE ... % page 0 n = 8 8R

The retrieved ECG is now ready for printout in the working memory (press **COPY**), and is still available in the long-term memory.

nD delete ECG from file n

When retrieving an ECG from the long-term memory the ECG data are not deleted but only copied. You use the specific command "nD" for deleting an ECG.

ATTENTION: Make sure that you have selected the right page and typed the right number, otherwise you may lose important data.

This will be confirmed with an acoustic signal and you see on the screen:

ECG deleted
FREE ... % page 1 n = 9 9D

nP patient data from file n

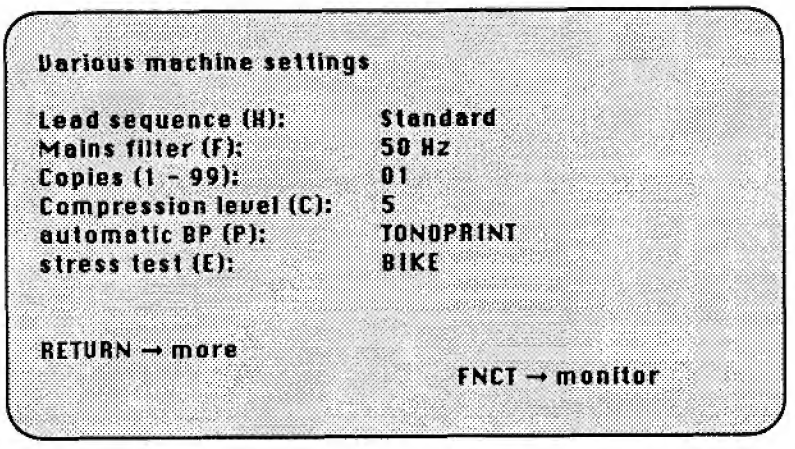
With this command, you can call up the complete patient data including the date and time of the recording but it is not possible to change them.

H display commands

By pressing **H** during any of the memory procedures, you can return to the main "Memory store" menu at any time.

2. VARIOUS SETTINGS

In the Various Settings menu, some further settings are listed. By pressing key **V**, the first page of the menu appears. With **RETURN**, one or two further pages can be called up. Each setting is executed by pressing the character indicated in brackets.



2.1 Lead Sequence

The lead sequence is switched with key **X**: The parameter changes from STANDARD to CABRERA and vice versa.

2.2 Mains Filter

The mains filter is switched by means of key **F** from 50Hz to 60Hz or switched off .

2.3 Number of Copies

The number of copies can be preselected (enter a number between 01 and 99). This function produces a constant number of ECG copies whenever **COPY** is pressed or when **START** is pressed in Automatic mode.

2.4 Compression Level

In order to store more ECGs in the long-term memory, the ECG data are reduced by a data compression procedure. Analysis and interpretation, however, always refer to the original ECG signals.

The compression level is set with key **C**, and you can choose between the following values: 5, 10, 20, 30µV. When these ECGs are reprinted, the waveform is slightly changed. At a compression level of 30µV, the reduction is greatest and so is the deviation. At 5µV, the reduction is small and thus the deviation form the original ECG very slight.

In the event of strong muscle tremor an error message may appear because the deflection will not be sufficiently levelled. In such a case, the ECG cannot be stored in the long-term memory.

2.5 Automatic Blood Pressure Measurement

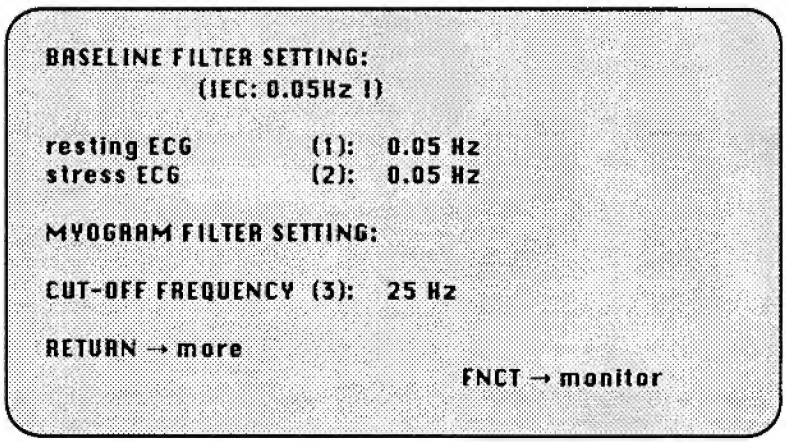
By pressing **P**, the desired unit for automatic blood pressure measurement can be selected. The choice available is TONOPRINT or EBM 502.

NOTE: This setting is only for use when your CARDIOVIT AT-6 is equipped with the optional RS-232 serial interface.

2.6 Exercise Test Ergometer

With key **E**, the ergometer for an exercise test can be selected (see Chapter 3).

With **RETURN** you move to the next page:



2.7 Baseline Filter

In order to suppress excessive baseline drifts (e.g. during stress tests), a digital baseline filter has been designed. The baseline filter is set separately for resting and exercise ECGs. With key **1** (for resting ECGs) or key **2** (for exercise ECGs) you can choose between the following values: 0.05, 0.12, 0.25, 0.50Hz.

The value set is now the lower limit of the frequency range and is normally set to 0.05Hz (IEC recommended), ie, a frequency range of 0.05 to 100Hz. The settings 0.12, 0.25 and 0.50Hz should only be used when absolutely necessary as the possibility exists that they could affect the original ECG signal, especially the ST segments.

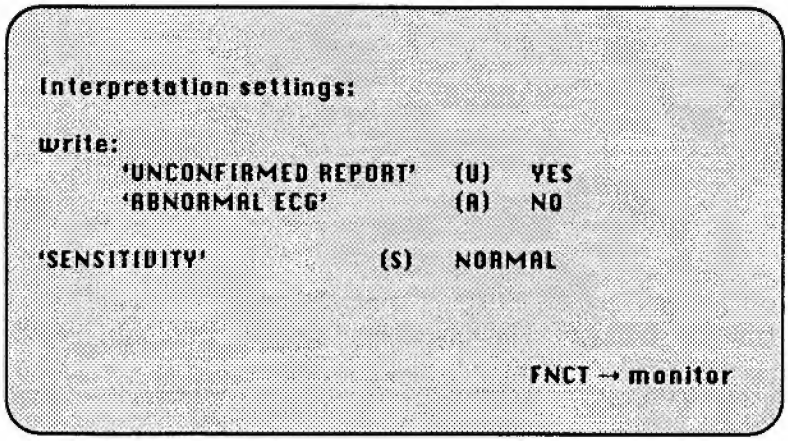
2.8 Myogram Filter

The myogram filter suppresses disturbances caused by strong muscle tremor. The filter is switched on and off by means of the **FILT** key. It is possible to print the stored ECG either with or without passing the myogram filter.

The cut-off frequency can be set by pressing key **3**, which switches the value from 25 to 35Hz and back again.

The value set will be the new upper limit of the frequency range as soon as the **FILT** key is switched on.

By pressing **RETURN**, you can move on to the third page. This page applies to C versions only:



2.9 Interpretation Settings

Here you can determine whether the indications 'UNCONFIRMED REPORT', key **U**, and/or 'ABNORMAL ECG', key **A**, will be added to the interpretation statements. The required sensitivity, 'NORMAL' or 'LOW', can be selected by pressing key **S**.

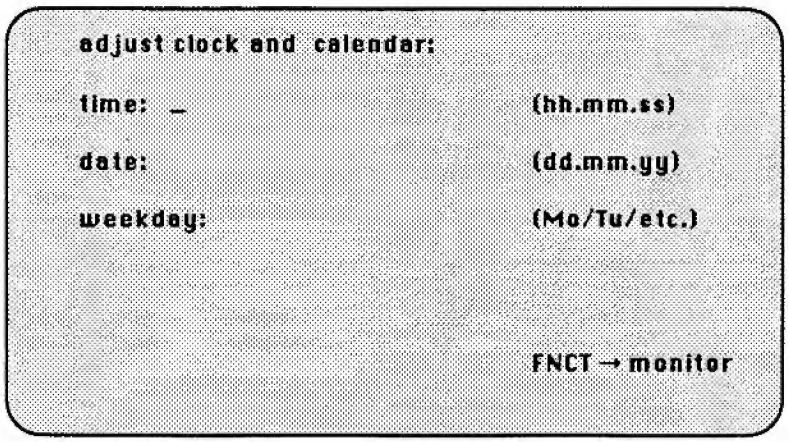
Selection of 'LOW' sensitivity suppresses certain non-specific ECG findings and is recommended for situations such as mass screening. Selection of 'NORMAL' sensitivity cancels the suppression of non-specific ECG findings and is recommended for situations where a more detailed patient examination is required.

NOTE: For a complete listing of statements at normal sensitivity, and an explanation of statements at low sensitivity, see Chapter 6, *Option 2 : SCHILLER ECG Interpretation Program.*

3. ADJUSTING CLOCK AND CALENDAR

The CARDIOVIT AT-6 contains a calendar clock running on its own battery, independently of the mains supply, i.e. it is running even if the unit is switched off. The battery life is approx. 8 years.

The number of days per month and the leap years are already preprogrammed and the time is adjusted to Central European Time (CET). If the time or date have to be changed, press **U** to call up the menu for adjusting the clock and calendar and the following appears on the display:



Time: The time has to be entered in hours, minutes, seconds. For example, for 6.05 p.m., enter "18.5.0" or 18.05.00". The newly entered time is valid as soon as **RETURN** is pressed.

Date: The date is entered as day, month, year. For example, for 11th December, 1987 enter "11.12.87".

Weekday: The day of the week is entered by typing in the first two letters: Mo, Tu, We, Th, Fr, Sa, Su.

As soon as **RETURN** is pressed, the entered values are stored and the cursor moves to the next line.

Wrongly entered figures can be deleted with the **DEL** key. If an impossible date (e.g. 42.5.85) is entered, the whole line is deleted and a question mark appears. The cursor remains on the same line and awaits the entry of a new, correct date.

Press **FNCT** to return to the Monitor mode.

Chapter 5

CARE AND MAINTENANCE

CONTENTS

1. CARE OF YOUR CARDIOVIT AT-6

The casing of the CARDIOVIT AT-6 should be cleaned with a soft cloth on the surface only. *Switch the unit off before cleaning.*

Do not, under any circumstance, immerse the apparatus into a cleaning liquid or sterilize with hot water, steam, or air.

The patient cable should not be exposed to excessive mechanical stress. Whenever disconnecting the leads, hold the plugs and not the cables. Store the leads in such a way as to prevent anyone stumbling over them or any damage being caused by the wheels of instrument trolleys.

The cable can be wiped with soapy water. Sterilization, if required, should be done with gas only and not with steam. To disinfect, wipe the cable with one of the following products (do not dip into liquid!):

Incidin GG
Amocid
Lysoformin
Alhydex

The electrodes are cleaned after every use with soapy water. Make sure that no water is left in the suction cup of the suction electrodes. Sterilization can also be performed with gas or with Alhydex or Vygon.

2. SELF-TEST

Each time the unit is switched on, a self-test is carried out to check all the functions. By pressing key **T**, the self-test can be initiated at any time. A table giving information for the service staff appears on the screen. To exit the self-test, press **FNCT** and the display returns to the Monitor mode.

3. TESTING THE ELECTRODE CABLES

The electrode leads are checked for short-circuit and interruption by means of the test socket on the right-hand side of the unit. Ensure that the CARDIOVIT AT-6 is switched on and the patient cable plugged in. Now insert the electrode plug into the test socket. If the control light is illuminated there is no defect.

4. MAINTENANCE

At 12-monthly intervals, the unit should undergo a technical safety check. The extent of this check should include the following:

- visual inspection of the unit
- visual inspection of accessories
- protective earth conductor test
- insulation test
- leakage current test
- calibration test
- check of alarm functions
- check of unit functions

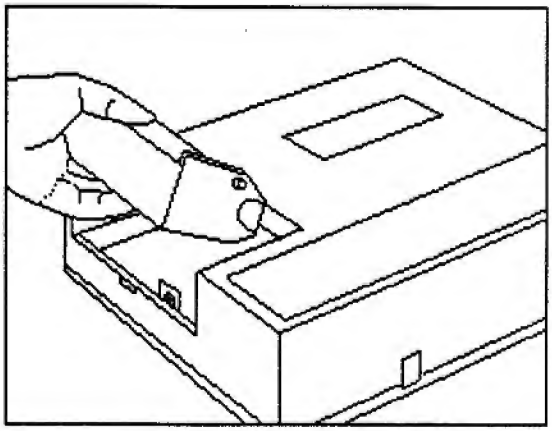
The test results should be documented and entered in the equipment book. Tables for the entry of this data are provided at the end of this manual.

5. REPLACING THE RECORDING PAPER

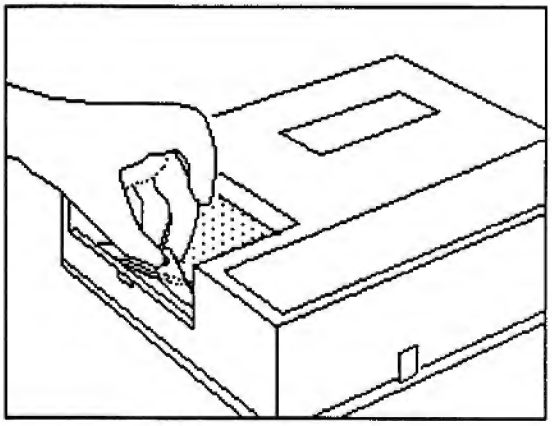
The chart paper can easily be replaced. As soon as the end of the paper is indicated on the lower edge, replace it with a new package. After the indication first appears, there are about 100 cm left. However, we recommend that the paper be renewed immediately.

If no paper is left, the printing process is interrupted. On the screen, a corresponding remark appears.

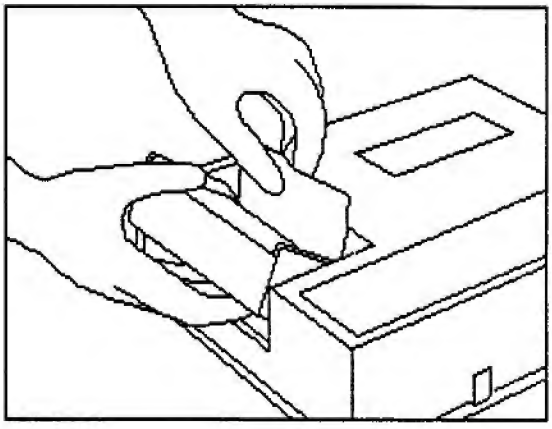
- Push paper compartment release and lift off cover



- Remove remains of paper by means of cellophane strip.
- Fold back top sheet of new paper package by one inch and put it into paper compartment.



- Pull up beginning of paper, reinsert cover and place paper over guide roller.
  Check for correct paper alignment.
- Close paper compartment by pressing lightly until release catches.
- Press the **STOP** key and the paper is transported to the correct starting position.



After the paper has been replaced, the printout is started again by pressing **START.**

SCHILLER can only guarantee impeccable printing quality if Schiller chart paper or paper of equal quality is used.

Chapter 6

OPTIONS

CONTENTS

Option 1: SCHILLER ECG Measurement Program

Option 2: SCHILLER ECG Interpretation Program

Option 3: Rhythm and Heart Rate Monitoring

Option 4: RS-232 Computer Interface

Option 5: EXEC Analysis Program for Exercise ECGs

Option 6: Video Monitor

1. INTRODUCTION

The basis for an interpretion with the SCHILLER ECG interpretion program or a diagnosis by the physician is the SCHILLER ECG measurement program. It measures the ECG signal and presents the results clearly arranged.

1.1 Heart Rate (HR)

Average heart rate calculated on the basis of the entire recording (10 seconds) and is shown as number of beats per minute.

1.2 Intervals

RR: Average time interval between two consecutive ventricular complexes, computed on the basis of the average heart rate.

PP: Duration of P wave (interval between markings 1 and 2 of the average ECGs)

PQ: P-Q interval, i.e. period of time between beginning of P wave and beginning of QRS complex (markings 1 and 3 of average ECGs)

QRS: Duration of QRS complex (time interval between markings 3 and 4 of average ECGs)

QT: Interval between beginning of QRS (beginning of ventricular depolarisation) and end of T wave (end of repolarisation phase)

QTC: Normalized QT interval. As the QT interval is dependent on the heart rate, it is often converted into the normalized QTC interval (i.e. the QT the patient would show at a HR of 60/min). Usually, the QTC amounts to 390 ±40 msec. The conversion is achieved according to the following formula:

$$QTC = QT * \sqrt{\frac{1000}{RR}}$$

1.3 Electrical Axes

The electrical axes of the heart are determined separately for the P, T and QRS waves. They indicate the main spreading direction of the electrical vector in the *frontal plane.*

The SCHILLER measurement program calculates the axes on the basis of the maximal deflection of the relevant waves in the leads I and aVF. The following formula is used for the calculation:

$$\text{axis } \alpha = \arctan[\max(aVF) / \max(I)]$$

Please notice that large discrepancies may be found between two measurings if the P and T waves are poorly distinct. It is also a known fact that breathing and the position (supine or standing) of the patient produce changes in the electrical axes.

1.4 Detailed Measurements for Each Lead

The SCHILLER mesurement program prints a table with lead-specific measuring results.

In 12 columns, i.e. for each standard lead, the amplitude values of the P, Q, R, S, R', S' T, and T' waves, the J point and the ST integral are listed in millivolts (mV). The amplitude measurements relate to a reference value that correponds to the signal value immediately before the beginning of the QRS complex (marking 3 on the average ECGs). The duration of the Q, R, S, R' and S' waves is indicated in milliseconds (ms).

The measurements are designated as follows:

P:	amplitude of P wave
Q:	amplitude of Q wave
Qd:	duration of Q wave
R:	amplitude of R wave
Rd:	duration of R wave
S:	amplitude of S wave
Sd:	duration of S wave
R':	amplitude of R' wave
R'd:	duration of R' wave
S':	amplitude of S' wave
S'd:	duration of S' wave
J:	amplitude of J point (marking 4 of average ECGs)
ST:	ST integral: averaged amplitude of ST segment (from J point to half the distance between J-point and T wave maximum)
T:	amplitude of T wave
T':	amplitude of T' wave (in case of a diphasic T wave)

1. INTRODUCTION

The SCHILLER ECG Interpretation program was developed in co-operation with leading European cardiologists and is designed to assist the physician in reading and evaluating the ECG print-out.

Before listing the statements, we would like to briefly recall the essential principles of ECG analysis and evaluation.

The ECG evaluation should always be systematic and conducted in a predetermined order. Before each ECG evaluation, you should verify whether the recording was done correctly and whether the patient received any heart-active medicine (digitalis, beta-blockers, antiarrhythmics, diuretics etc.). Clinical findings and diagnosis have to be known to the evaluating person.

The following procedure is recommended for evaluation:

1. Determine rhythm or rhythm disturbances.
2. Determine heart rate.
3. Measure duration of P, PQ, QRS and QT.
4. Systematic examination of P, Q, R, S, T waves and ECG segments (ST segment etc).
5. Determine electrical axes in extremity leads and evaluate precordial leads (R/S ratio, transitional zone etc).
6. Brief description of exceptional and abnormal signs within each single section of the waveform.
7. Overall evaluation.

In this process, you are optimally supported by the SCHILLER ECG Interpretation program. It supplies the necessary measurement data and suggestions for interpretation.

2. EXPLANATION OF INTERPRETATION STATEMENTS

On the following pages is an explanation of the possible findings which can result from the interpretation program. Each explanation is accompanied by one of the following general classification statements:

Normal ECG
Otherwise normal ECG
Borderline ECG
Possibly abnormal ECG
Abnormal ECG

2.1 Rhythm

Premature atrial contraction(s)
One or several premature beats of the same shape as the predominant beats were detected in the absence of atrial fibrillation.
Bigeminy will appear in addition to this statement if at least three supraventricular extrasystoles are detected, each separated from the preceding one by a single predominant beat.
Trigeminy will appear in addition to this statement if at least three supraventricular extrasystoles are detected, each separated from the preceding one by two predominant beats.
(OTHERWISE NORMAL ECG)

Atrial escape beat(s)
A pause longer than 1.5 times the predominant R-R interval preceded one or several beats of the same shape as the predominant beats in the absence of atrial fibrillation.
(OTHERWISE NORMAL ECG)

Premature Ventricular contraction(s)
One or several premature beats, differing in shape and size from the predominant beats were detected.
Bigeminy will appear in addition to this statement if at least three ventricular extrasystoles are detected, each separated from the preceding one by a single predominant beat
Trigeminy will appear in addition to this statement if at least three ventricular extrasystoles are detected, each separated from the preceding one by two predominant beats.
(ABNORMAL ECG)

Ventricular escape beat(s)
A pause longer than 1.5 times the predominant R-R interval preceded one or several beats differing in shape and size from the predominant beats in the absence of atrial fibrillation.
(ABNORMAL ECG)

Beat(s) with aberrant intraventricular conduction
One or several beats were detected differing in shape and size from the predominant beats, but occurring in time, i.e. separated from the preceding and following beats by the predominant R-R interval.
(OTHERWISE NORMAL ECG)

Sinus rhythm
A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the R-R intervals between the predominant beats was no greater than 15%.
(NORMAL ECG)

Sinus arrhythmia
A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the R-R intervals between the predominant beats was greater than 15%.
(OTHERWISE NORMAL ECG)

Sinus bradycardia
A P wave was detected in the averaged ECG cycle, and the heart rate was less than 50 beats per minute.
(OTHERWISE NORMAL ECG)

Sinus tachycardia
A P wave was detected in the averaged ECG cycle, and the heart rate was greater than 100 beats per minute.
(OTHERWISE NORMAL ECG)

Supraventricular tachycardia
A P wave was detected in the averaged ECG cycle, and the heart rate was greater than 130 beats per minute.
(OTHERWISE NORMAL ECG)

Nodal rhythm
No P wave was detected in the averaged ECG cycle, the heart rate was less than or equal to 60 beats per minute, the QRS duration of the predominant beats was less than 150 ms and the difference in the duration of the R-R intervals between the predominant beats was less than 15%.
(ABNORMAL ECG)

Regular rhythm, no P wave found
No P wave was detected in the averaged ECG cycle, the heart rate was greater than 60 beats per minute, and there was less than 15% difference in the duration of the R-R intervals between the predominant beats.
(POSSIBLY ABNORMAL ECG)

Idioventricular rhythm
No P wave was detected in the averaged ECG cycle and the QRS duration of the predominant beats was greater than 150 ms. The heart rate was less than or equal to 40 beats per minute, and there was less than 15% difference in the duration of the R-R intervals between the predominant beats.
(ABNORMAL ECG)

Ventricular tachycardia
No P wave was detected in the averaged ECG cycle and the QRS duration of the predominant beats was greater than 150 ms. The heart rate was greater than 150 beats per minute, and there was less than 15% difference in the duration of the R-R intervals between the predominant beats.
(ABNORMAL ECG)

Atrial fibrillation/flutter
No P wave was detected in the averaged ECG cycle, the heart rate was less than 95 beats per minute, and there was at least 15% difference in the duration of at least one R-R interval between the predominant beats.
(ABNORMAL ECG)

Atrial fibrillation with rapid ventricular response
No P wave was detected in the averaged ECG cycle, the heart rate was equal to or greater than 95 beats per minute, and there was at least 15% difference in the duration of at least one R-R interval between the predominant beats.
(ABNORMAL ECG)

Pacemaker spikes noted
More than two typical pacemaker spikes were detected in at least two leads of the original ECG data recorded over 10 seconds.
(ABNORMAL ECG)

2.2 Electrical Axis

The electrical axis is computed on the basis of the algebraic sum of the amplitudes and deflections of the QRS complex in leads I and aVF. The possible findings with their corresponding ranges are as follows:

Abnormal left axis deviation	-90°	to	-30°	(ABNORMAL ECG)
Leftward axis	- 30°	to	0°	(OTHERWISE NORMAL ECG)
Rightward axis	+90°	to	+110	(OTHERWISE NORMAL ECG)
Abnormal right axis deviation	+110°	to	+180°	(ABNORMAL ECG)
Abnormal right superior axis deviation	- 90°	to	-180°	(ABNORMAL ECG)

Indeterminate axis
The algebraic sum of the deflections of the QRS complex in leads I and aVF ranged between -0.15 mV and +0.15 mV.
(BORDERLINE ECG)

2.3 Atrial Activity

For the detection of a **Left Atrial Abnormality**, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria:

Terminal negative phase of P in V1:	1 point if 40 ms < terminal negative phase ≤ 70 ms. 2 points if 70 ms < terminal negative phase ≤ 100 ms. 3 points if 100 ms < terminal negative phase.
Maximal negative P amplitude in V1:	1 point for every 0.01 mV of amplitude < -0.10 mV.
P terminal negative force in V1: (= maximal negative amplitude of P times terminal negative phase of P)	1 point if -6 mVms > P terminal force ≥ -8 mVms. 2 points if -8 mVms > P terminal force.

Possible left atrial abnormality
Four or five points have been attributed in the test above.
(POSSIBLY ABNORMAL ECG)

Left atrial abnormality
Six or more points have been attributed in the test above.
(ABNORMAL ECG)

For the detection of a **Right Atrial Enlargement**, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria:

P-amplitude in II:	1 point if 0.25 mV≤ P amplitude < 0.3 mV. 2 points if the P amplitude ≥ 0.3mV.
P-amplitude in III:	1 point if 0.25 mV≤ P amplitude < 0.3 mV. 2 points if the P amplitude ≥ 0.3mV.
P-amplitude in aVF:	1 point if 0.25 mV≤ P amplitude < 0.3 mV. 2 points if the P -amplitude ≥ 0.3mV.

Right atrial enlargement
The test for right atrial enlargement yielded at least three points.
(POSSIBLY ABNORMAL ECG)

Biatrial enlargement
The conditions for (possible) left atrial abnormality (at least four points in the test) and (possible) right atrial enlargement (at least two points in the test) have been satisfied.
(ABNORMAL ECG)

Prolonged P-R interval
The duration of the P-R interval was longer than: $21 \times \sqrt[4]{10 \times \text{R-R interval}} + 10$ [ms] or 220 ms, whichever is less.
(ABNORMAL ECG)

2.4 ECG Voltages

Low limb lead voltage
The sum of the peak-to-peak QRS amplitudes in leads I, II and III was 1.5 mV or less, but one or several peak-to-peak QRS amplitudes in the chest leads was greater than 0.7 mV.
(BORDERLINE ECG)

Low voltage
The sum of the peak-to-peak QRS amplitudes in leads I, II and III was 1.5 mV or less, and the difference between the maximal QRS amplitudes in V4-V6 and the minimal QRS amplitudes in V1-V3 was 0.7 mV or less.
(ABNORMAL ECG)

2.5 Blocks

Right bundle branch block
The total duration of QRS was at least 130 ms. The R/S ratio in lead V2 was greater than 1, or an S wave deeper than 0.20 mV was detected in leads I and V6. In lead V1 or lead V2 a notched QRS complex or a QRS complex of the RSR' type was found.
(ABNORMAL ECG)

Incomplete right bundle branch block
The total duration of QRS was shorter than 130 ms. In lead V1 or lead V2 a notched QRS complex or a QRS complex of the RSR' type was detected and the R' wave in one of those two leads had an amplitude of at least 0.15 mV.
(OTHERWISE NORMAL ECG)

Left bundle branch block
The total duration of QRS was at least 130 ms. The R/S ratio in lead V2 was less than 1. If an S wave was found in leads I and V6, it was not deeper than -0.2 mV and the R/S ratio was ≥ 1. The Q wave amplitude in either lead I or lead V6 was $\geq$ -0.09 mV.
(ABNORMAL ECG)

Incomplete left bundle branch block
Same as left bundle branch block, except that the total duration of QRS was shorter than 130 ms and longer than or equal to 120 ms.
(POSSIBLY ABNORMAL ECG)

Non-specific intraventricular block
The total duration of QRS was at least 130 ms. The criteria for left bundle branch block, right bundle branch block, left anterior or left posterior fascicular block were not fulfilled.
(ABNORMAL ECG)

Non-specific intraventricular delay
The total duration of QRS was shorter than 130 ms but longer than or equal to120 ms. The criteria for incomplete left bundle branch block, incomplete right bundle branch block, left anterior or left posterior fascicular block were not fulfilled.

(BORDERLINE ECG)

Left anterior fascicular block
No Q wave was present in lead aVF, i.e. the ventricular depolarisation started in a downward direction. The R/S ratio in lead aVF was 0.6 or less, and the electrical axis ranged between -30 and -120 degrees. An S wave with an amplitude of ≤ -0.25 mV must be present in lead V6.

(ABNORMAL ECG)

Left posterior fascicular block
The electrical axis ranged between +90° and +180°. The Q wave amplitudes in II, III and aVF were ≥ -0.02mV, and the Q durations in III, aVF were ≤ 40 ms. The R or R' amplitude in II was ≥ 0.8 mV, and in III ≥ 1.0 mV.

(ABNORMAL ECG)

Bifascicular block
A left anterior fascicular block or a left posterior fascicular block occurred together with a right bundle branch block.

(ABNORMAL ECG)

2.6 QRS Abnormalities

QRS (T) contour abnormality, cannot rule out anteroseptal myocardial damage
There was a pathological start of the ventricular depolarisation. The initial momentary QRS vectors were directed backward and mostly to the left, and remained in this direction during the greater part of the ventricular depolarisation, instead of remaining directed forward for the first 30 ms then turning backwards and to the left.

(BORDERLINE ECG)

QRS (T) contour abnormality, cannot rule out anterolateral myocardial damage
The ventricular depolarisation started normally, the initial momentary QRS vectors being directed forward and to the right. However, instead of then turning to the left and backwards, the momentary QRS vectors turned further to the right and backwards.

(BORDERLINE ECG)

QRS (T) contour abnormality, cannot rule out lateral myocardial damage
The ventricular depolarisation started normally, the initial momentary QRS vectors being directed forwards and to the right. However, instead of then turning to the left and backwards, the momentary QRS vectors remained directed forwards and more to the right than normal, i.e. the turn to the left was postponed.

(BORDERLINE ECG)

QRS (T) contour abnormality, cannot rule out inferior myocardial damage
The initial 10 to 20 ms momentary QRS vectors were directed upward, which is still normal, but instead of turning immediately downwards, the momentary QRS vectors remained directed upward for at least the first 40 ms of the ventricular depolarisation and often remained directed upwards during the greater part of the ventricular depolarisation.

(BORDERLINE ECG)

CANNOT RULE OUT is substituted by CONSIDER in the above statements if in addition to the QRS contour abnormality pathognomonic inverted T waves were detected in appropriate leads, i.e.
- II and aVF for inferior localisation
- V1, V2 and V3 for anteroseptal localisation
- V4, V5 and V6 for anterolateral localisation
- I and aVL for lateral localisation

2.7 Myocardial Infarctions

A diagnosis of myocardial infarction requires the detection of at least one pathognomonic Q or QS wave (Q/QS), i.e. a Q-wave which measures at least 25% of the amplitude of the following R wave in leads I, II, aVL, aVF, or V1 to V6.

The ECG interpretation program enables the detection of myocardial infarctions within the following areas:

septal	Q/QS in V2
anteroseptal	Q/QS in V2 and V3, Q/QS in V1 to V3.
anterior	Q/QS in V4, or any combination of Q/QS in V4 with Q/QS in any other precordial lead
anterolateral	Q/QS in V5 or in V5 and V6
lateral	Q/QS in V5 and/or V6 and Q/QS in I and/or aVL
high lateral	Q/QS in I and aVL
inferolateral	Q/QS in II and/or aVF and Q/QS in V6
inferior	Q/QS in II and/or aVF

A diagnosis of myocardial injury will be replaced by a diagnosis of myocardial infarction if a Q/QS was detected in the anteroseptal, anterolateral, anterior or high lateral localisation as defined above.

If only one Q/QS was detected in a certain area, the following diagnosis will appear:

QRS (T) contour abnormality, consider.....Infarct

If more than one Q/QS was detected in a certain area, the following diagnosis will appear:

QRS (T) contour abnormality, consistent with.....Infarct

Exception: The septal location is always associated with "cannot rule out".

The patient however must be at least 30 years old otherwise INFARCT will be substituted by MYOCARDIAL DAMAGE.

When a diagnosis of myocardial infarction is proposed, the program endeavours to determine its age.

Probably old will appear if no specific ST and T changes were detected in the leads defining the infarct localisation.

Possibly recent will appear if a significant ST elevation was detected in the leads defining the infarct localisation.

Age undetermined will appear in all other cases.

A diagnosis of myocardial infarction will always have the classification ABNORMAL ECG.

2.8 ST-T Morphology

ST abnormality, possible anteroseptal subendocardial injury
ST depressed by at least 0.25 mV in at least one of leads V1, V2 and V3, and no QRS signs of an anteroseptal myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST abnormality, possible anterior subendocardial injury
ST depressed by at least 0.25 mV in other precordial lead combinations than those typical for anteroseptal and anterolateral injuries, and no QRS signs of an anterior myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST abnormality, possible anterolateral subendocardial injury
ST depressed by at least 0.25 mV in at least one of leads V4, V5 and V6, and no QRS signs of myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST abnormality, possible lateral subendocardial injury
ST depressed by at least 0.25 mV in leads V5 and V6, and at least 0.1 mV in leads I and aVL, and no QRS signs of a lateral myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST abnormality, possible inferior subendocardial injury
ST depressed by at least 0.1 mV in leads II and aVF, and no QRS signs of an inferior myocardial injury or infarct were detected.
(ABNORMAL ECG)

Non-specific ST depression
ST depressions other than those mentioned above were detected.
(BORDERLINE ECG)

ST & T abnormality, consider anteroseptal ischemia or right ventricular strain
ST depressed by 0.05 to 0.09 mV with T diphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, diphasic or negative in at least one of leads V1, V2 and V3, and no QRS signs of an anteroseptal myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST & T abnormality, consider anterior ischemia or left ventricular strain
ST depressed by 0.05 to 0.09mV with T diphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, diphasic or negative in other precordial lead combinations than those typical for anteroseptal and anterolateral ischemia or left ventricular strain.
(ABNORMAL ECG)

ST & T abnormality, consider anterolateral ischemia or left ventricular strain
ST depressed by 0.05 to 0.09 mV with T diphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, diphasic or negative in at least one of leads V4, V5 and V6, and no QRS signs of an anterolateral myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST & T abnormality, consider lateral ischemia or left ventricular strain
ST depressed by 0.05 to 0.09 mV with T flat, diphasic or negative in at least one of leads I, aVL and V6 and no QRS signs of a lateral myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST & T abnormality, consider inferior ischemia or left ventricular strain
ST depressed by 0.05 to 0.09 mV with T flat, diphasic or negative in leads II or aVF, and no QRS signs of an inferior myocardial injury or infarct were detected.
(ABNORMAL ECG)

ST & T abnormality, consider recent ..... myocardial or pericardial damage
ST elevated at least 0.20mV in at least two V leads or two inferior leads (II, aVF, III) and followed by a flat or negative T-wave, and no QRS signs of a myocardial damage or infarct were detected within the same localisation.
(ABNORMAL ECG)

Non-specific ST-T abnormality (elevation)
An ST elevation of at least 0.2 mV was detected accompanied by a T wave in the same lead higher than the normal upper limits as given below in at least two V leads or two arm leads.
(OTHERWISE NORMAL ECG)

T abnormality in anteroseptal leads
T diphasic or negative in at least one of leads V2 and V3, and no QRS signs of an anteroseptal myocardial injury or infarct were detected.
(ABNORMAL ECG)

T abnormality in anterior leads
T diphasic or negative in other precordial lead combinations than those typical for anteroseptal and anterolateral myocardial injuries was detected.
(ABNORMAL ECG)

T abnormality in anterolateral leads
T diphasic or negative in at least one of leads V4, V5 and V6, and no QRS signs of an anterolateral myocardial injury or infarct were detected.
(ABNORMAL ECG)

T abnormality in lateral leads
T diphasic or negative in at least one of leads I, aVL and V6, and no QRS signs of a lateral myocardial injury or infarct were detected.
(ABNORMAL ECG)

T abnormality in inferior leads
T diphasic or negative in lead II or aVF, and no QRS signs of an inferior myocardial injury or infarct were detected.
(ABNORMAL ECG)

Non-specific T abnormality
T changes other than those mentioned above were detected.
(BORDERLINE ECG)

T-wave table (amplitudes in mV)

		aVL	I	-aVR	II	aVF	III
NORMAL	Upper limit	0.22	0.35	0.34	0.43	0.31	0.22
	Lower limit	-0.05	0.07	0.09	0.08	0.00	-0.12
FLAT	Lower limit	--	-0.04	-0.04	-0.04	-0.04	--
NEGATIVE	Upper limit	-0.06	-0.05	-0.05	-0.05	-0.05	-0.13

		V1	V2	V3	V4	V5	V6
NORMAL	Upper limit	0.39	1.01	1.07	1.04	0.78	0.49
	Lower limit	-0.13	0.17	0.20	0.16	0.13	0.08
FLAT	Lower limit	--	-0.04	-0.04	-0.04	-0.04	-0.04
NEGATIVE	Upper limit	-0.14	-0.05	-0.05	-0.05	-0.05	-0.05

2.9 Q-T Interval

Prolonged QT
A QTc duration longer than or equal to 470 ms was detected.
(BORDERLINE ECG)

2.10 Hypertrophy

For the detection of a **Left Ventricular Hypertrophy**, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria (modified Romhilt-Estes point score):
QRS amplitudes: 3 points if

- the sum of the R-amplitude in lead V5 and the absolute value of the S-amplitude in lead V1 exceeds an age and sex-dependent limit (Sokolow-Lyon). For every 0.5 mV above the limit, a further point is attributed.
- the greatest R or S deflection in the extremity leads was equal to or greater than an age and sex-dependent limit (For every 0.3 mV above the limit, a further point is attributed.), or
- the greatest S deflection in leads V1 to V2 was equal to or greater than an age and sex-dependent limit (For every 0.5 mV above the limit, a further point is attributed.), or
- the greatest R deflection in leads V5 to V6 was equal to or greater than an age and sex-dependent limit (For every 0.5 mV above the limit, a further point is attributed.).

From the last three criteria, the one with the most points is chosen.

ST & T: 3 points if

- an ST depression and a negative or diphasic T wave were detected in leads I, aVL, aVF, V5 or V6. Only 1 point is attributed when the patient is under digitalis medication.

LAA: 3 points if

- left atrial abnormality is present and the amplitude criteria scored at least 3 points.

Electrical axis: 2 points if

- QRS axis ranged from -15 to -120 degrees.

Other QRS criteria: 1 point each if

- the interval between the onset of QRS and the maximum QRS vector was longer than 55 ms, and
- the total duration of QRS was longer than 110 ms.

No search for LVH is done in the presence of LBBB, RBBB, unspecific intraventricular Block or WPW.

Consider left ventricular hypertrophy
The patient is at least 18 years old and the ECG scored at least 7 points according to the criteria above (3 of these points must stem from the amplitude criteria).
(POSSIBLY ABNORMAL ECG)

Left ventricular hypertrophy
The patient is at least 18 years old and the ECG scored 9 points according to the criteria above (3 of these points must stem from the amplitude criteria).
(ABNORMAL ECG)

Amplitude criteria for left ventricular hypertrophy
The patient is at least 18 years old and of all criteria for left ventricular hypertrophy, only the amplitude criteria were satisfied, and with 6 points.
(POSSIBLY ABNORMAL ECG)

Moderate amplitude criteria for left ventricular hypertrophy
The patient is at least 18 years old, and of all criteria for left ventricular hypertrophy, only the amplitude criteria were satisfied, but only with 3 to 5 points.
(BORDERLINE ECG)

For the detection of a **Right Ventricular Hypertrophy**, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria:

Amplitudes: 3 points if
- the R deflection in lead V1 was greater than an age- and sex-dependent limit and the S deflection in the same lead was not deeper than an age and sex-dependent limit (these limits are different in the case of an incomplete or complete RBBB), and
- an S wave deeper than an age and sex-dependent limit was detected in lead V5 or V6, and the R/S ratio was less than an age and sex-dependent limit in these leads.

ST & T: 2 points if
- an ST depression and a negative or diphasic T wave were detected in leads V1 to V3. Only 1 point is attributed when the patient is under digitalis medication.

Electrical axis: 2 points if
- The QRS axis ranged from +90 to +180 degrees, or from -120 to -180 degrees.

QRS duration: 1 point if
- the total duration of QRS ranged from 100 to 120 ms.

No search for RVH is done in the presence of a WPW.

Consider right ventricular hypertrophy
The ECG scored at least 5 points according to the above criteria or 4 points in the presence of a right atrial hypertrophy or of a sagittal electrical axis (i.e. S1S2S3 pattern).
(POSSIBLY ABNORMAL ECG)

Right ventricular hypertrophy
The ECG scored 6 points according to the above criteria or 5 points in the presence of a right atrial hypertrophy or of a sagittal electrical axis (i.e. S1S2S3 pattern).
(ABNORMAL ECG)

2.11 Miscellaneous Statements

S1, S2, S3 pattern
An S-wave of at least 0.2 mV was detected in leads I, II and III, and the R/S quotient did not exceed 0.25 in the same leads.
(OTHERWISE NORMAL ECG)

WPW pattern, type A
The duration of QRS was at least 130 ms and the duration of PR shorter than 150 ms. A prolonged ventricular activation time, accompanied by a slope significantly less steep than normal during the first 40 ms of the QRS complex was detected in at least two V leads. The QRS area was positive in lead V1.
(ABNORMAL ECG)

Consider WPW, type B
The duration of QRS was at least 130 ms and the duration of PR shorter than 140 ms. A prolonged ventricular activation time, accompanied by a slope significantly less steep than normal during the first 40 ms of the QRS complex was detected in at least two V leads. The QRS area was negative in lead V1.
(ABNORMAL ECG)

R-S transition zone in V leads displaced to the right
An R/S quotient of at least 3 was detected in lead V2, and the duration of QRS was not longer than 120 ms.
(OTHERWISE NORMAL ECG)

R-S transition zone in V leads displaced to the left
An R/S quotient less than 0.75 was detected in lead V5, and the duration of QRS was not longer than 120 ms.

(OTHERWISE NORMAL ECG)

• Possible reversal of the arm leads
The QRS complexes in leads I and V6 were more discordant than concordant, and the P-wave in lead I was negative.

2.12 Low Sensitivity Statements

When 'LOW' sensitivity is selected, the following statements regarding non-specific ECG findings will be suppressed:

- Indeterminate axis
- Low limb lead voltage
- Non-specific intraventricular delay
- Prolonged QT
- Non-specific ST depression
- Non-specific T abnormality
- Cannot rule out myocardial damage
- Moderate amplitude criteria for LVH

If one of the above statements has been suppressed, and no other abnormalities are found, the normal/ abnormal classification will be replaced by "No specific ECG abnormalities".

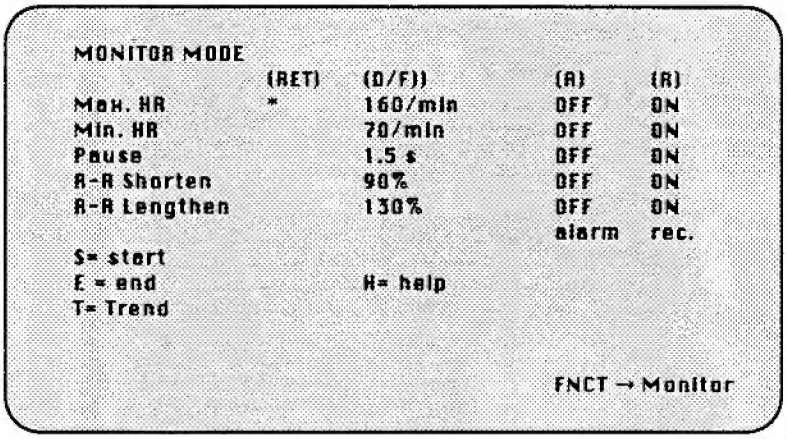
The statement 'Atrial fibrillation/flutter' is replaced with "Irregular rhythm, no P-wave found".

1. INTRODUCTION

The CARDIOVIT AT-6 can be equipped with rhythm and heart rate monitoring software for the purpose of mobile and stationary patient monitoring. Heart rate, pauses and rhythm variations are recognised and recorded. A trend diagram is produced from the course of the heart rate.

2. SELECTING RHYTHM AND HEART RATE MONITORING

When a unit is equipped with the monitor mode option, then press **N** when in Monitoring mode to call up the following table for rhythm and heart rate monitoring :



The individual limit values can now be set. By pressing **RETURN**, the cursor can be moved to the next line, the current line being indicated by an asterisk.

The limit values are entered into the first column by using keys **D** and **F**. Values can be selected within the following ranges:

Max. heart rate:	70 to 250 beats per minute
Min. heart rate:	20 to 150 beats per minute
Pause:	1.5 to 5.0 seconds
R-R interval reduction:	20 to 90% of normal length
R-R interval increase:	110 to 190% of normal length

In the second column, key **A** is used to determine whether or not an acoustic alarm should sound when each of the set limit values is either reached or exceeded. (When the alarm sounds, it can be cancelled by pressing **DEL**.)

In the third column, key **R** is used to select a print-out of an event recording. The 3 freely selected leads will be printed out over a period of 4 seconds. This print-out comprises 1 page, however an event series will comprise 3 pages (ie 12 seconds).

The Help menu giving a brief explanation of the monitor mode settings can be called to the display at any time by pressing key **H**.

2.1 Starting and Termination of Monitoring

Rhythm and heart rate monitoring are started by pressing key **S**. At the bottom of the display, the letter "M" appears to indicate that monitoring is in progress.

As soon as a limit value is either reached or exceeded, an acoustic alarm is sounded and/or an event recording is printed out. The acoustic alarm can be acknowledged and cancelled by pressing **DEL**. An ECG print-out can be manually initiated at any time during monitoring.

There is no limit to the duration of patient monitoring. The heart rate trend diagram is produced from the the last 2 hours.

The monitor program can be stopped by pressing key **E**.

2.2 Heart Rate Trend

During the course of the heart rate, a trend diagram is produced which can either be called to the display by pressing key **T**, or printed out by pressing key **P**.

The entered values for maximum and minimum heart rate are indicated on the diagram with dotted lines. The last two hours are shown, whereby the time axis at 30 minutes switches to 60, and at 60 switches to 120.

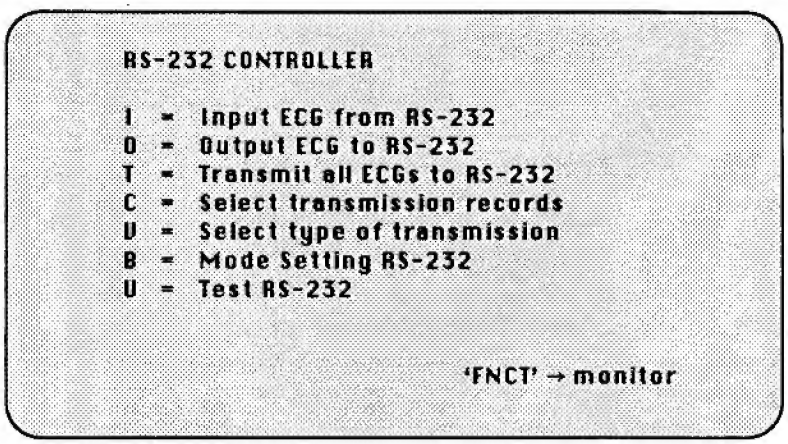
The trend diagram remains stored in the memory until either the unit is switched off or the monitoring program is restarted.

1. SETTING UP THE TRANSFER CONDITIONS

The CARDIOVIT AT-6 can only process ECG data recorded by a CARDIOVIT unit. Therefore, the data transfer takes place either between a CARDIOVIT AT-6 unit and another unit in the CARDIOVIT family (e.g. via a telephone modem) or between a computer (PC or main frame) and the CARDIOVIT AT-6.

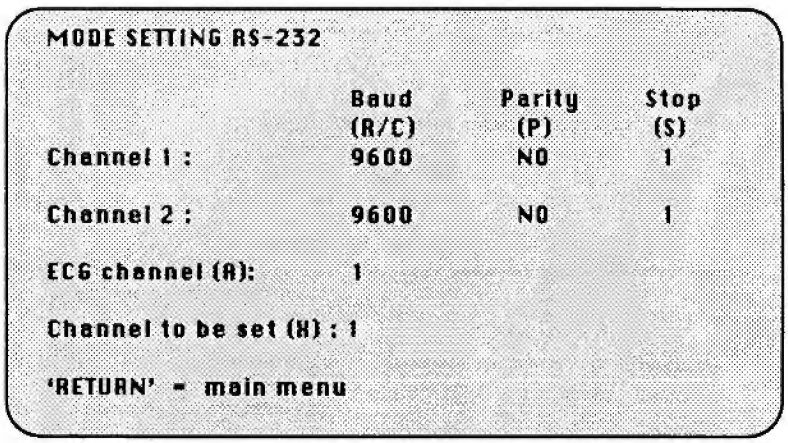
The operation and setup of the RS-232 interface takes place using the RS-232 CONTROLLER menu. Press key **X** to call this menu to the display.

NOTE: The RS-232 Controller menu can only be called up when the recording and evaluation of a resting ECG in Automatic mode (key **AUTO**) is completed. Similarly, transmission of an EXEC exercise ECG should first be initiated *after* the Final Report has been printed out and *before* quitting the Exercise Test mode.



1.1 Adjusting RS-232

Before a transfer, the technical parameters of the two units have to be matched. Press key **B**:



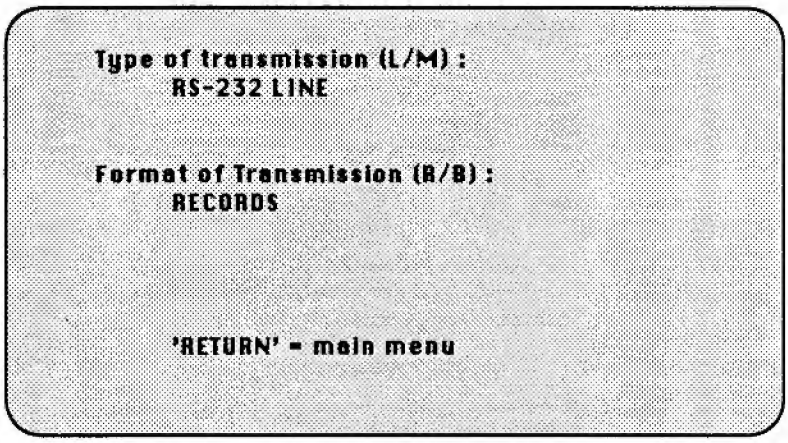
There are two input/output channels available. Press key **X** to select the required channel, then select the following:

- The **baud rate** is selected with key **R** (increase) or **C** (decrease). The following values can be set: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 baud.
- The **parity bit** is set with key **P**. You can choose between: EVEN, ODD, or NO.
- The **length of the stop bit** is determined with key **S**. Possible are: 1, 1.5, or 2 units.

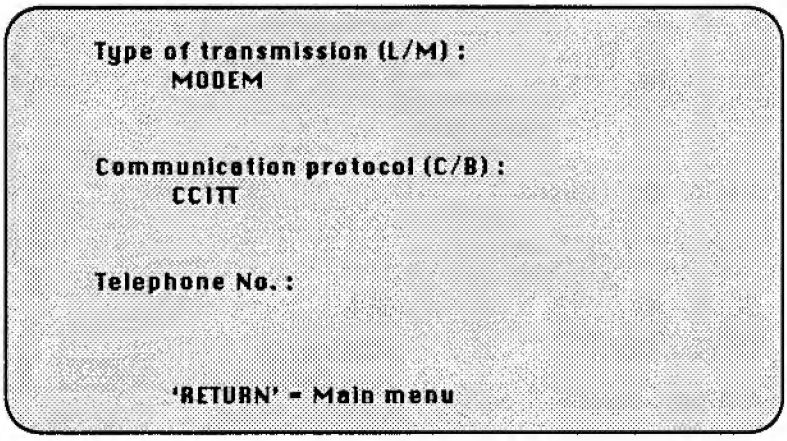
The channel for the input or output of data is selected with key **A**. Normally, the ECG is transmitted via channel 1.

1.2 Select Type of Transmission

Press **V** to call up the following table:



The parameter **Type of transmission** is switched with **L** to "RS-232 line" if the two units are connected directly. If the transmission is executed via telephone, i.e. a modem, **M** has to be selected here. The display changes to the input table for the phone number which will be dialled automatically when the connection is demanded.

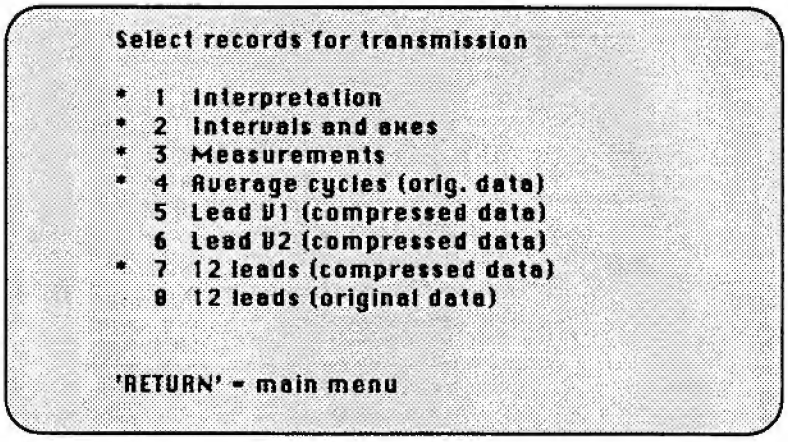


This menu also enables the Communication Protocol to be selected by pressing **C** for CCITT, or **B** for BELL. Press **L** to return the menu to the first page.

For the **Format of transmission**, there are two possibilities: The transmission of records (**R**) is faster and easier to implement in the receiving unit. The transfer of blocks (**B**) is on the other hand more secure, as the transmitted data is checked for errors and corrected accordingly. Blocks (**B**) is always selected when the type of transmission is set to modem.

1.3 Selecting the ECG Data for Transmission

Using the menu "Select records for transmission", the contents of the data to be transmitted can be selected. Press **C**:



By pressing the indicated characters (1 - 7), the data to be transferred can be freely combined. With key **8**, only the original data will be sent and selections 1 to 7 are suppressed. Each selection is indicated by an asterisk (*) on the left-hand side.

NOTE: The leads indicated at "5" and "6" are those previously selected for rhythm leads R1 and R2, see Chapter 2, para. 3.2.

Press **RETURN** to return to the main menu.

2. TRANSFER OF ECG DATA

2.1 Input ECG from RS-232

By pressing key **I**, the input of an ECG is started and the message "receiving ECG data" is displayed on the screen. The external ECG data is transferred to the memory, from where it is immediately printed out.

When the reception of ECG data is complete, the display reads: "AT-6 ready to receive". Press **RETURN** to return to the main RS-232 menu.

2.2 Output ECG to RS-232

In order to send ECG data, i.e. the contents of the memory, press letter **O**. Once transmission is completed, the acknowledgement "ECG IS OUTPUT TO RS-232!" is given on the display. If no ECG is in the memory when **O** is pressed, an audible alarm is sounded and the message "NO ECG IN MEMORY" is given on the display.

Press **RETURN** to return to the main RS-232 menu.

2.3 Output all ECGs to RS-232

If it is required to send ECGs stored in the long-term memory, press key **T** and all the ECGs stored will be transferred in one lot. When the transfer is complete, the following message appears: "ECGs OUTPUT TO RS-232!". If there are problems with the modem transmission, the AT-6 will automatically restart the transmission up to three times.

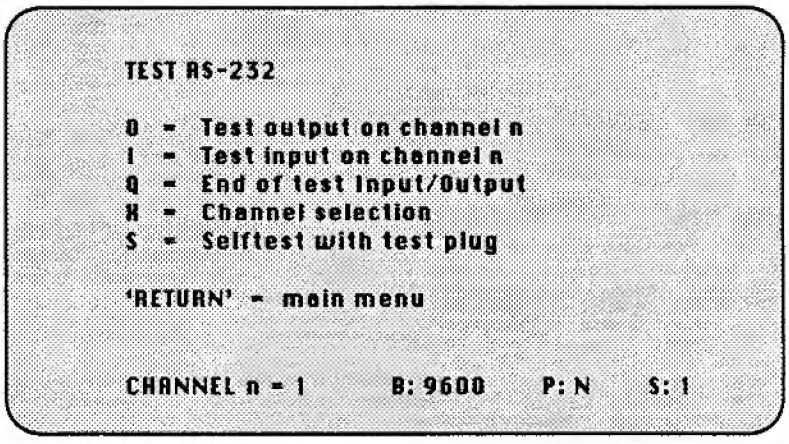
3. ERROR MESSAGES

If one of these commands cannot be executed for any reason, an error message appears instead of an acknowledgement:

SERIAL LINK TIME-OUT	This indication appears if no signal is received for approx. 40 seconds (e.g. if the connecting cable is not or not properly plugged in).
RECEPTION ERROR (PARITY)	Either the parity is not set correctly or there is actually a parity error.
RECEPTION ERROR (OVERRUN)	This concerns a system error. Please contact the service organization.
RECEPTION ERROR (FRAMING)	Either there is a transmission error or the baud rate is set incorrectly.
DATA SET NOT READY!	The ECG data cannot be fed out since the receiving unit is still not ready for operation after 40 seconds.

4. TEST PROCEDURES FOR THE RS-232

To test the RS-232 interface, connect the CARDIOVIT AT-6 to an external unit and press key **U** to call the test menu to the display:



The channel to be tested can be selected by pressing **X**. The number of the selected channel and its settings are given at the bottom of the display.

With **O**, the output of data can be tested. With **I**, the data input is tested. The output or input test is interrupted by pressing key **Q**.

The self-test must be carried out using a special test plug and can therefore only be performed by authorised service personnel.

Press **RETURN** to return to the main RS-232 menu.

1. INTRODUCTION

EXEC is a special program for the real time recording and evaluation of all the data accumulated during exercise stress testing. With the help of established signal processing algorithms, EXEC carries out a complete analysis of the ECG (12 simultaneous leads). Furthermore, specific parameters such as blood pressure are entered, co-ordinated according to time and finally integrated into the final report.

Main objective of the EXEC program is to accomplish an accurate evaluation of stress testing and to document all relevant information clearly and concisely.

2. DESCRIPTION OF THE EXEC PROGRAM

2.1 Determination of the Dominant QRS Cycle

EXEC localizes, measures and classifies each recorded ECG cycle. In order to have an efficient beat classification, precise knowledge of the "normal" QRS type is a prerequisite. For this purpose, a learning process is necessary, which the EXEC carries out immediately after starting a stress test, i.e. during stage P. EXEC informs itself in the first place about the frequency of the occuring QRS patterns. The first five QRS are used for the learning process. From these five complexes a characteristic vector is acquired, which describes the dominant QRS type. This so-called reference vector now serves as a comparison vector for subsequent classification of all the accumulated ECG cycles.

As the shape of the QRS can change continuously during the stress test, EXEC adapts the reference vector to the changes. When the QRS changes are abrupt - e.g. at an intermittent bundle branch block - a new learning process is automatically initiated.

The duration of the learning process depends on the heart rate. As a rule it lasts for 8 - 12 seconds.

2.2 QRS Classification

After concluding the learning process, EXEC is in a position to process each ECG cycle immediately. With the help of artefact-insensitive measuring algorithms, EXEC determines a charateristic vector that specifies the QRS complex to be processed and which is structurally identical to the reference vector. Both these characteristic vectors are then compared via a certain decision logic procedure. Through a suitable combination of the measurement results, taking into consideration the empirically determined tolerance range, EXEC classifies the measured QRS.

Each QRS is classified for signal processing and for medical criteria. The possible classes and the respective processing are shown in the tables below:

Signal Processing Classes		
Class	**Description**	**Processing**
1.1	Dominant QRS type without strong distortion	Averaging/Update reference vector/Heart rate calculation
1.2	Dominant QRS type with strong distortion	Heart rate calculation/No averaging
1.3	Non-dominant QRS type	Heart rate calculation/No averaging
1.4	Artefact	No heart rate calculation/No averaging

The classification from the signal processing view, is essential in determining whether or not a beat can be used for averaging.

2.3 Construction of the Representative Cycles (Averaging)

The aim to reduce the superfluous information and at the same time increase the quality of the interpretation is attained through the computation of representative ECG cycles. The representative cycle (standard cycle) always corresponds to the actual normal cycle.

For the formation of a genuine standard cycle free of artefacts, the established method of beat averaging is provided. This is an efficient method to dispose of artefacts, a method that uses the peculiarities of the ECG signals. On principle one utilizes the characteristics of the ECG as a redundant periodic process. The average complex formed by a multitude of normal beats full of artefacts thus leads in the proximity of the artefact free original signal.

EXEC uses an incremental-averaging-algorithm with base-line correction. This is a method, which allows the recurring parts of the signal only to be fed into the result. The average cycle is always up-to-date and available at any time.

2.4 Analysis of the ST Segment

On the averaged cycle the ST analysis occurs every 4 seconds. EXEC determines the position of the J point with the help of a pattern recognition process (template method). If the J point, in relation to the resting cycle, is higher by 0.1 mV, the system would then classify it as ST elevation. The analysis of the ST segment shape thus becomes superfluous. The same applies for the ST amplitudes which differ between 0.1mV and -0.1 mV. The ST segment is then classified as unobtrusive. In case the ST amplitude is lower than -0.1 mV, EXEC identifies an ST depression and carries out an analysis of the shapes of the ST segment in the first 80 milliseconds. It also determines whether the ST segment in this area is fairly rectilinear. Should this be the case, the slope of the regression line in the first 40 milliseconds serves as a measure for classification.

The following table shows the ST classifications and their respective criteria:

Degree	Abbr	Class	J-amplitude Δ (mV)	ST shape	Slope (mV/sec)
0	-	unobtrusive	0.1 > J > 0.1		
1	AS	ascending	J < -0.1	rectilinear	s > 1.0
2	SA	slowly ascending	J < -0.1	rectilinear	1.0 > s > 0.1
3	HD	horiz/descending	J < -0.1	rectilinear	0.1 > s
4	CC	concave	J < -0.1	basin-shaped	
5	EL	ST elevation relative to resting ECG	0.1 < J		

2.5 Determining the Heart Rate

The heart rate is constantly computed from the last eight RR intervals. A beat is however only taken for the calculation of the heart rate if it is recognized as a normal beat (class 1.2) or if it has the same medical classification as the preceding beat (e.g. with ventricular tachycardia).

2.6 Metabolic Equivalents (METS)

Exercise tests carried out with a treadmill also provide a MET value for each test stage. The metabolic equivalents, or METS, provide a simple means of determining energy expenditure during exercise.

One MET is defined as the resting metabolic rate, ie the amount of oxygen consumed when seated at rest. Thus, an individual exercising at 2 METS requires twice the resting metabolism, and at three METS requires three times the resting metabolism.

The provision of a MET value for each stage of an exercise test assists in determining the exercise tolerance of a patient in conjunction with factors such as weight, degree of fitness, sex and age.

3. WORKING WITH EXEC

The EXEC program does not have to be selected, every time you call up exercise testing, the EXEC program is operational. EXEC can be used for exercise testing with either a bicycle ergometer or a treadmill.

The program for exercise testing is called up by pressing key **E** (see Chapter 3). The settings and adjustments are as described for exercise testing in Chapter 3, however with EXEC installed, there are several additional functions. In the main Exercise Test menu, the following two additional points are included on the second page:

F = format of final report
R = printout of rhythm

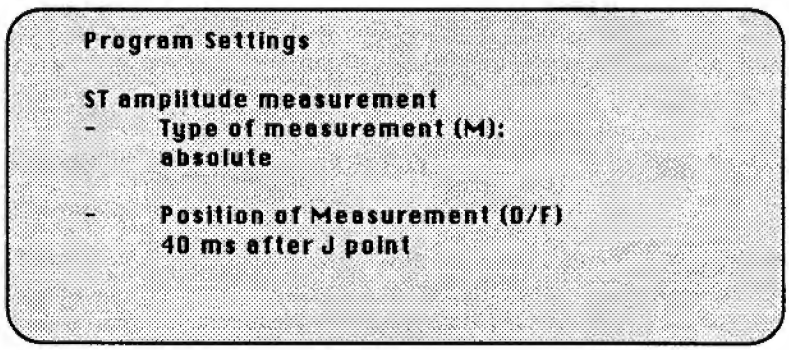
In addition, a third page of the main Exercise Testing menu is now available containing the following two items:

H = RS-232 control
U = input of program settings

Before starting the exercise test, some EXEC specific settings have to be made apart from those described in Chapter 3.

3.1 ST Measurement

In the Exercise Testing menu, press key **U** (located on the third page of the menu) to call up the submenu for Program Settings as follows:



By pressing key **M** you can select the type of ST measurement to be made, ie either 'Absolute' or 'normalised to R'. This enables the ST amplitude to be shown either as an absolute value, or normalized for each lead to the maximal R amplitude. This means, that an ST depression in leads with large R amplitudes are of less importance than in leads with small R amplitudes. Conversion is done according to the following formula:

$$Jxn = Jx \ / \ F(\text{R amplitude,1 mV})$$

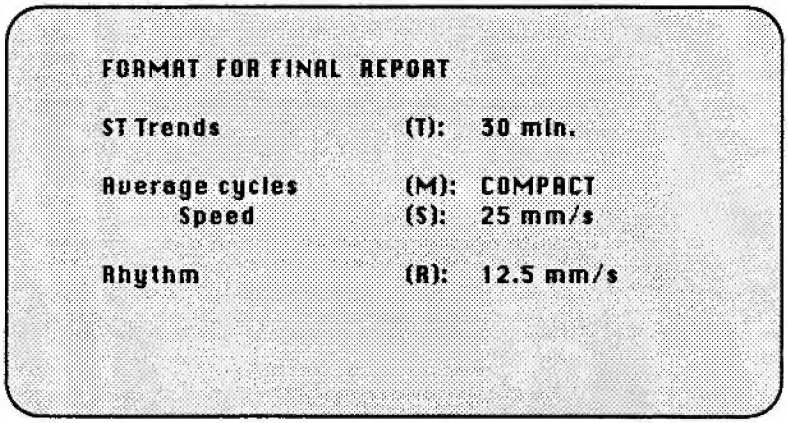
whereby
x = amplitude measuring point
Jxn = normalized ST amplitude
Jx = absolute ST amplitude

With keys **D** (decrease) and **F** (increase), the position of the amplitude measuring point within the ST segment is determined. The given temporal distance is measured from the beginning of the ST segment, i.e. the J point. The measurement point can thus be set to either 00, 10, 20, 30, 40, 50, 60, 70 or 80ms after the J-point.

Press **FNCT** to return to the main menu.

3.2 Format for Final Report

The content of the final report can be selected to provide the required information. Press key **F** (in the Exercise Test menu) and the following menu is displayed:



With key **T**, you can determine whether the **ST trend diagrams** are to be suppressed (- - - -), or printed on a time scale of 30 minutes. The trend diagrams are printed for each lead and show the ST amplitude as a solid line and the ST slope as a dotted line. The ST amplitude measurement point and the unit values for both amplitude (mV) and slope (mV/s) are given at the top of the page.

With key **M**, the **average cycles** can be suppressed (- - - -), printed in a condensed format (COMPACT) or printed out in detail (ALL). You can further set the chart speed with key **S** to either 25 or 50 mm/s. With the COMPACT format, an average cycle is printed out for each lead for the resting phase, maximum load, one minute into the recovery phase and the end of the recovery phase. When ALL is selected, then one average cycle is printed out for each lead for every load step as well as for the 1st, 2nd, 4th, 6th, 8th and 10th minute of the recovery phase up to a maximum of 30 cycles. The average cycles are always printed out in 6-channel mode.

NOTE: If required, the sensitivity for the average cycles can be set to 5, 10 or 20mm/mV by pressing **FNCT** to return to monitor mode, selecting the required sensitivity and then returning to the exercise test menu (key **E**) before starting the printout.

For the printout of the **rhythm** recording the speed can be set to either 6.25 or 12.5 mm/s or can be suppressed (- - - -).

NOTE: If a rhythm printout is only required in the event of rhythm disturbances, select '- - - -' to suppress the automatic printout and at the end of the test, after the final report has been printed out, press **R** and the rhythm strip will be printed out separately.

Press **FNCT** to return to the main Exercise Test menu.

After interrupting the test, the heart rate and blood pressure measurements continue. Once the recovery phase is completed, the final report can be printed out by pressing key **S**.

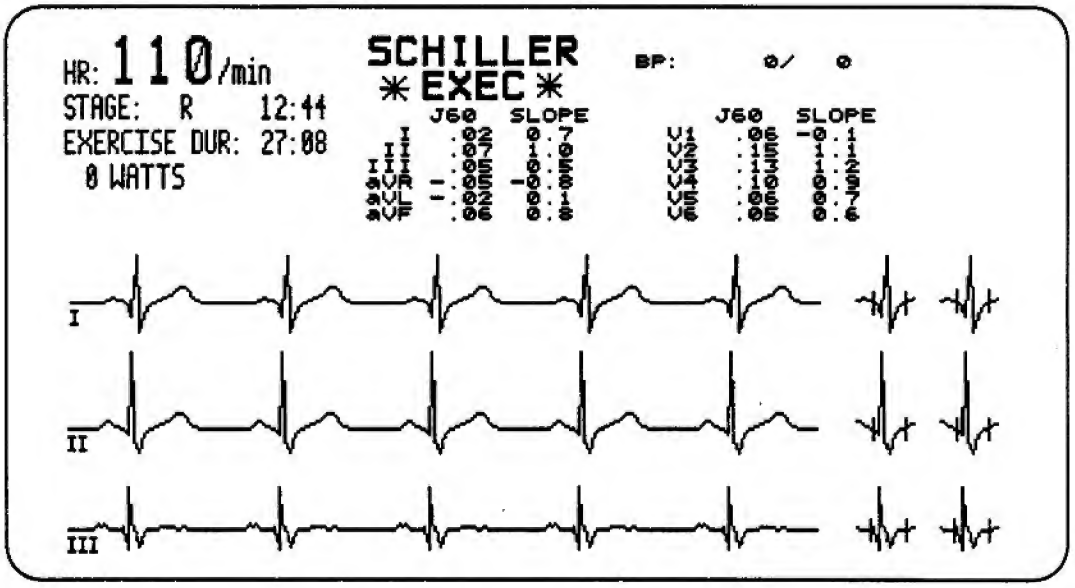
3.3 Starting the Exercise Test

The exercise test is started by pressing key **B.** At first there is a pre-exercise phase, during which a resting ECG is recorded for comparison purposes. During this phase, the patient should quietly sit or stand on the ergometer or treadmill. After a minute the first load stage is initiated.

During the test, average complexes are continuously being computed and further analyses made. The results are shown on the video monitor. At the pre-set intervals, a complete ECG will be printed out. On the LC display and on the periodic printout, the test duration, the duration of the load step, the actual load step and the effective load will be indicated.

3.4 Displayed Information

On the video monitor, there are three different representations available, however each has the same information at the top of the screen. The first representation as shown below displays three freely selectable leads together with their average cycles from the resting ECG and the exercise ECG. The latter is continually renewed.



At the top of the screen the current test information and analysis results are displayed. At the top left of the screen, the current heart rate is shown and beneath the heart rate is the stage identification (P = Pre-exercise phase, 1 to 9 = stage number, R = recovery phase) and the stage duration. Below this is the total test duration and the bottom line indicates the current load for bicycle ergometers. For exercise tests with a treadmill, the information block at the top left of the screen appears as follows:

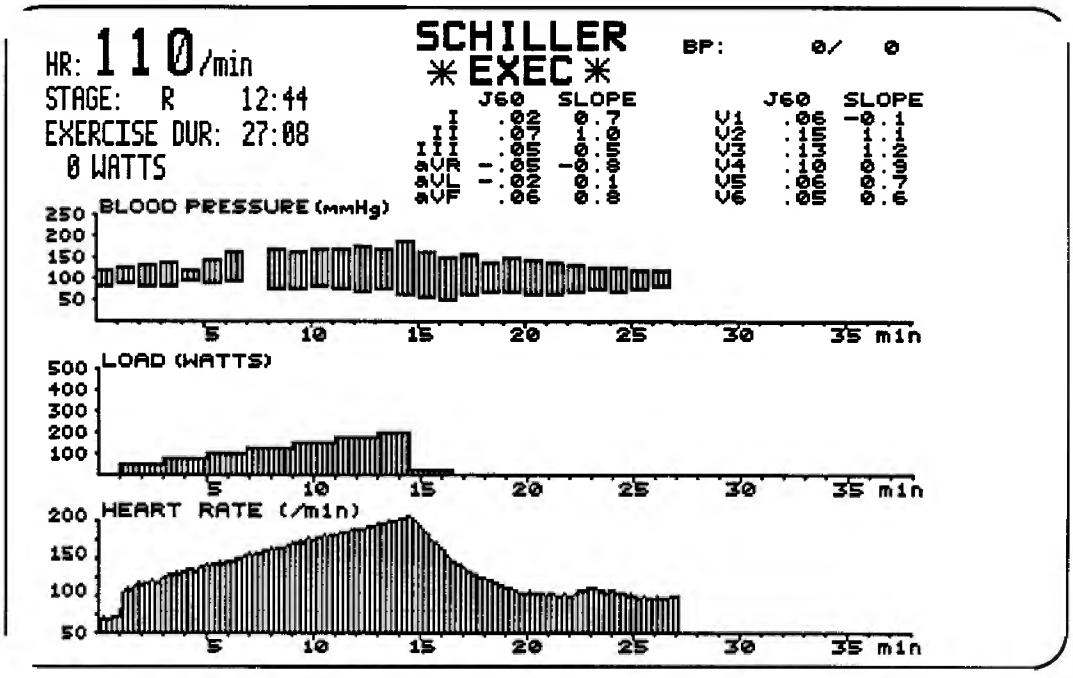
Here, the treadmill speed and elevation are given together with the metabolic equivalents (METS) for the current stage.

To the right at the top of the screen, the current blood pressure is displayed. The table below is arranged in four columns which give, from left to right:

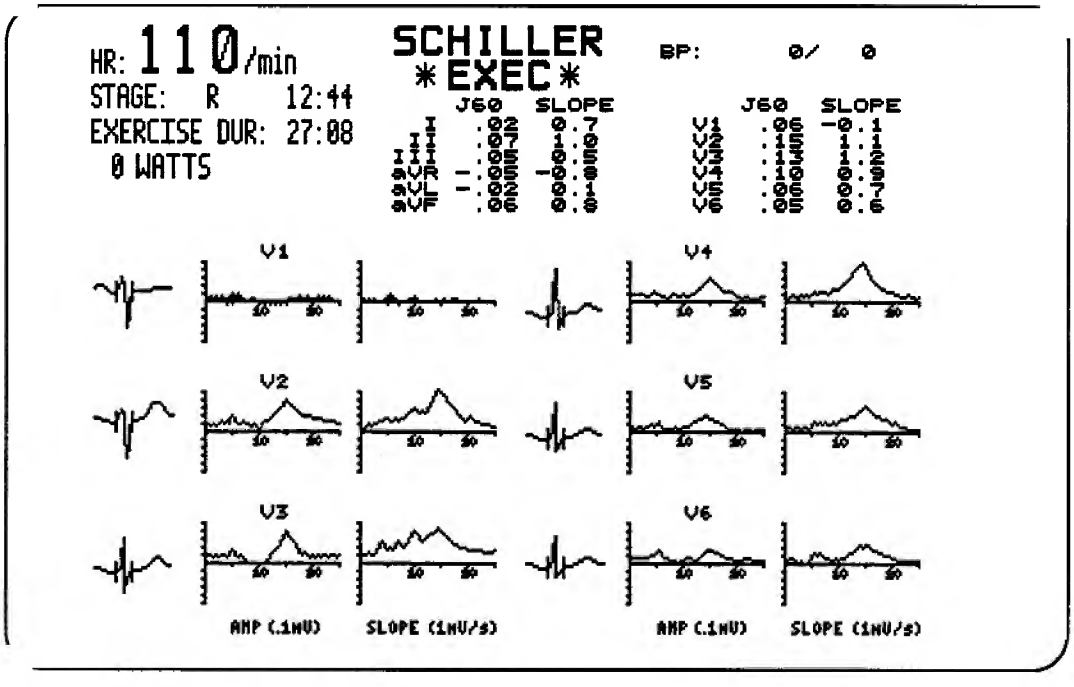
- the lead identification
- the current ST amplitude (in mV) together with the type of ST measurement and the measurement point (eg J80n = measurement normalised to R and taken at 80 ms after J-point)
- the slope of the ST segment (in mV/s)
- the analysis of any significant ST segment changes. The abbreviations used are as follows:

  E = ST elevation
  AS = ST depression with ascending ST slope
  SA = ST depression with slowly ascending ST slope
  HD = ST depression with horizontal or descending ST slope
  CC = ST depression with concaved ST slope

By pressing key **Z**, the video monitor can be switched to the trend plots of the blood pressure, load and heart rate as follows:



By pressing key **Z** once again the first display of a detailed summary of the occurences in the extremity or chest leads (average complex, ST amplitude trend, ST slope trend) is displayed and pressing **Z** a further time switches the monitor to the second summary display as follows:



Press key **Z** to return to the first representation of three leads.

3.5 Interrupting the Exercise Test

After reaching an interruption criterion, the test is discontinued by pressing either key **A** (recovery phase is immediately initiated with a "PEAK EXERCISE" printout) or key **L** (recovery phase initiated at end of current load stage). During the recovery phase, which is indicated on the screen by the letter R, all recordings are continued and protocolled.

Select the relevant end point criteria (maximum of 2), press **FNCT** to return to the main Exercise Test menu and press **S** to print out the final report.

3.6 Transmitting Exercise ECG Data

If your CARDIOVIT AT-6 is equipped with the RS-232 Interface option and you require to transmit the Exercise ECG recording, then press key **X** to select the RS-232 Controller menu.

NOTE: Exercise ECG transmission can only take place after the final report has been printed out. Transmission must be initiated before quitting the exercise test mode (ie, before pressing **Q**).

The setting up of the transfer conditions and initiation of the transmission are carried out as described in Option 4, 'RS-232 Computer Interface' in this Chapter.

1. INTRODUCTION

The video monitor can be used for patient monitoring for resting ECGs and exercise tests. If the EXEC analysis program for exercise ECGs is used, then a video monitor is definitely needed .

For the CARDIOVIT AT-6, you can in principle use any video monitor that corresponds to the technical requirements. In any case, the ECG unit has to be equipped with a video interface and video software.

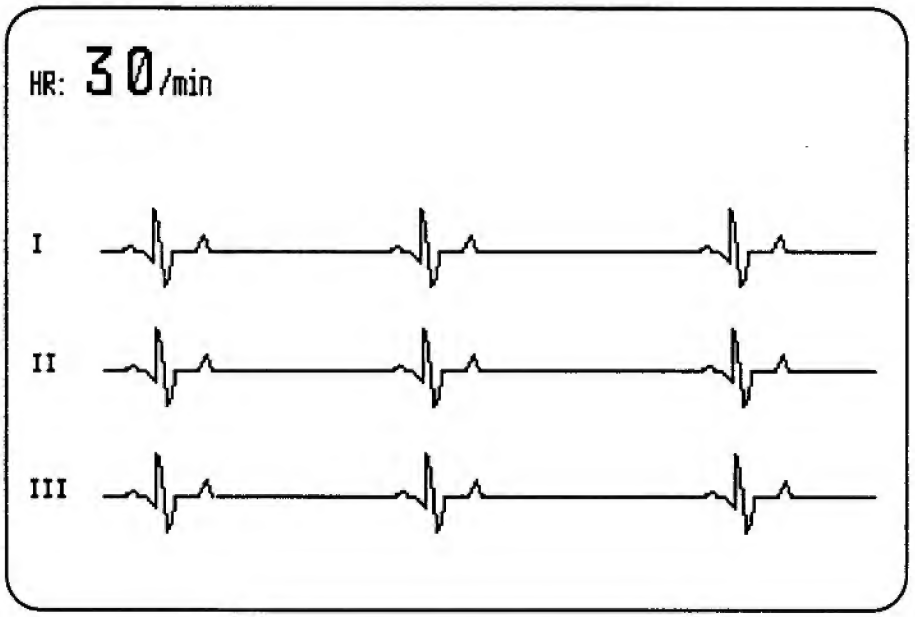
2. SETTING UP

Connect the video monitor to the mains supply and to the CARDIOVIT AT-6 (video connection on rear of unit). Secure the connection by tightening the two screws on the plug.

The video monitor can now be switched on.

3. PATIENT MONITORING

In the centre of the screen, three leads are shown. The actual heart rate can be seen in the upper left-hand corner. The lead group represented is that selected on the CARDIOVIT AT-6.



For details of the video monitor in conjunction with exercise testing using the optional EXEC analysis program, see Option 5.

Chapter 7

TECHNICAL DATA AND AVAILABLE CONFIGURATIONS

CONTENTS

1. TECHNICAL DATA

Dimensions	(l/w/h): 31 x 25 x 9cm
Weight:	approx. 4 kg
Power supply:	110/220 Vac. 50/60 Hz, and 12 V accumulator for more than 2 hours of line-independent operation
Power consumption:	recording: 18 W; standby: 7 W
Leads:	Standard / Cabrera /Frank XYZ / Nehb / further lead combinations freely programmable by the user
Paper speed:	2.5 / 5 / 10 / 50 / 100 mm/s
Sensitivity:	5 / 10 / 20 / 40 mm/mV: either automatically adjusted or manually selected
Chart paper:	thermoreactive, Z-folded,145 mm wide, 35 m long, perforation every 100 mm
Printing process:	high resolution thermal printhead, 8 dots per mm
Recording tracks:	3 to 6 channels, positioned at optimal width on 45 mm, automatic baseline adjustment
Automatic lead programs:	- 3 or 6 channel representation on one or two 300x145 mm forms (25 or 50 mm/s) - Versions M and C: average complexes of the 12 standard leads (25 mm/s) + 10s rhythm strip
Data record:	- Listing of ECG recording data, date and time of examination, patient data etc. - Versions M and C: ECG measurement results (intervals, amplitudes, electrical axes), average cycles with optional measurement reference markings - Version C: ECG interpretation statements
Long-term rhythm formats:	- 2 leads, 10 min per page - 1 lead, 15 min per page - 1 lead, 30 min per page
ECG storage:	- Output memory for 10s 12-lead ECG - Circular input memory for 10s 12-lead ECG: The last 10s ECG can be copied from input memory to output memory by pressing one key - Every ECG can be copied from the output memory any number of times - Up to 20 ECGs can be stored temporarily
LC display:	- Backlit liquid crystal display for ECG monitoring (1 or 3 leads) and alphanumeric information - Resolution: 128x256 dots
Calendar clock:	battery powered; durability >6 years, leap-years preprogrammed
Frequency range of digital recorder:	0 Hz - 120 Hz (IEC); 0 Hz - 150 Hz (AHA)

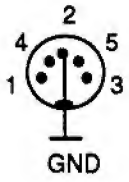
ECG amplifier:	- simultaneous registration of all 9 active electrode signals (= 12 standard leads) - sampling frequency: 800 Hz - digital resolution: 5 µV - dynamic range: ± 9 mV ac - max. electrode potential: ± 300 mV dc - time constant: 3.2s - frequency response: 0.05 - 280 Hz (-3dB) - common mode rejection:>100 dB, 50 / 60Hz - input impedance: >100 MOhm
Myogram filter (muscle tremor filter):	-3dB at 41 Hz, -6 dB/octave (only effective for printed ECG). The stored ECGs can be printed with or without filter.
Line frequency filter:	distortion-free suppression of superimposed 50 Hz sinusoidal interferences by means of an adaptive digital filter
DC Inputs:	2 differential inputs, sensitivity 0.5 V/cm, input impedance >2x100 kOhm
Signal outputs:	3 outputs. 1 V/cm, output impedance <100 Ohm, short-circuit-proof and overvoltage protected
Test socket for patient cable:	for testing of electrode cables for interruptions and short-circuit; defects indicated by the control light
Patient input:	fully floating and isolated, defibrillation protected
Patient leakage current:	less than 5µA
Safety standard:	CF according to IEC
Protection class:	I according to IEC, VDE and SEV
Environmental conditions:	- temperature, operating: 10° to 40°C - temperature, storage: 0° to 50°C - relative humidity: 15 to 85% (non-cond.)
Control panel and keyboard:	water and dustproof pad keys

Technical data subject to change without notice.

2. CONNECTOR PANEL

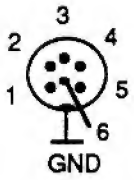
The connector panel, located on the right-hand side of the unit, has several input and output connections, the technical details for which are as follows:

Stress test interface
For connection of bicycle ergometer or treadmill
Input impedance: > 100 kOhm



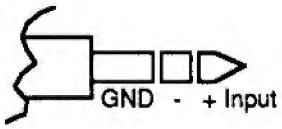
Pin 1 RPM Input: 100 RPM/V
Pin 2 GND
Pin 4 Load input: 100 W/V
Pin 5 Load output: 100 W/V

Scope output
Output level: 1 V/cm
Output impedance: < 100 Ohm
Short-circuit proof and overvoltage protected
Note: max. non-destructive voltage ±15 Vdc

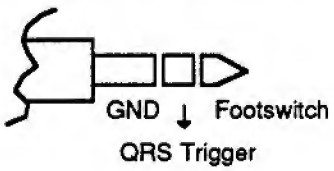


Pin 1 DC input - (DC3)
Pin 2 DC input + (DC3)
Pin 3 Output channel 1
Pin 4 Output channel 3
Pin 5 GND
Pin 6 Output channel 2

DC1, DC2 DC Inputs
Differential inputs
Sensitivity: 0,5 V/cm
Input impedance: > 100 kOhm
Maximum continuous voltage: 150V (short-term 220V)



ACC
footswitch (contact to GND = START)



QRS trigger 5V / 0V , 200 ms

3. RS-232 (V24) SERIAL INTERFACE (Option)

Baud rates:	300 - 38400 Baud
Byte format:	1 start bit, 8 data bits, 0 or 1 parity bit (+ or -), programmable 1 / 1.5 / 2 stop bits, programmable
Transfer control:	by means of DTR, DSR, CTS, RTS
connection socket:	D subminiature (25 poles), wired as DTE (data terminal equipment)

Pin connections:

2	TxD	0	(output data)
3	RxD	1	(input data)
4	RTS	0	(request for output)
5	CTS	1	(ready for output)
6	DSR	1	(transfer unit ready)
20	DTR	0	(AT-6 ready)
1			GND
7			GND (signal)

4. VIDEO MONITOR (Option)

Resolution:	850 x 350 dots	
Input signals:	horizontal sync.:	TTL (positive)
	vertical sync.:	TTL (negative)
	video:	TTL (positive)
Scanning frequency:	horizontal:	18.43 kHz
	vertical:	50 Hz

4.1 Video Interface on CARDIOVIT AT-6

1	= GND	6	= NC
2	= GND	7	= (+) VIDEO
3	= NC	8	= (+) H-SYNC
4	= NC	9	= (-) V-SYNC
5	= NC		

5. AVAILABLE CONFIGURATIONS

CARDIOVIT AT-6	Standard model
CARDIOVIT AT-6M	with measurement program for resting ECGs
CARDIOVIT AT-6C	with measurement and interpretation program for resting ECGs

5.1 Options

RS-232 serial interface	a V24 serial interface to enable the transfer of ECG data between the AT-6 and other CARDIOVIT units or a computer
HR Monitoring	additional software to enable both mobile and stationary rhythm and heart rate monitoring
EXEC analysis program for exercise ECGs	special program for the real-time recording of all data accumulated during exercise testing with clear and comprehensive reports
Video monitor	recommended for exercise testing, indespensible if the EXEC program is used
Pulmonary function testing	four modes for the measurement and calculation of inspiratory and expiratory values with visual presentation of all tests and clearly documented test results

5.2 Accessories

Standard accessories:

- 1 10-lead patient cable
- 6 precordial suction electrodes
- 4 extremity electrodes with rubber bands
- 1 flask of electrode gel
- 1 package of chart paper
- 1 power cord
- 1 ground lead cable
- 1 protective cover

Accessory options:

- carrying case
- foot switch

Chapter 8

TECHNICAL SAFETY CHECK

CONTENTS

TECHNICAL SAFETY CHECK

At 12-monthly intervals, the unit should undergo a technical safety check. The extent of this check should include the following:

- visual inspection of the unit
- visual inspection of accessories
- protective earth conductor test
- insulation test
- leakage current test
- calibration test
- check of alarm functions
- check of unit functions

The test results should be documented and entered in the equipment book. Tables for the entry of this data are provided on the following pages.

Technical Safety Check
Test Results

Equipment Number:	Type:

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Date:
Checked by:

Mains / Current

Volt amp.
Measurement current: amp.

Measurement Results

Protective earth conductor: Ω
Earth leakage current:
NC mA
SFC mA
Enclosure leakage current:
NC mA
SFC mA
Patient leakage current:
NC mA
SFC mA
Mains voltage on applied part:
SFC mA
Patient auxiliary current:
NC mA
SFC mA

Technical Safety Check
Test Results

Equipment Number:	Type:

Date: Checked by:	Date: Checked by:	Date: Checked by:
Mains / Current	Mains / Current	Mains / Current
Volt amp. Measurement current: amp.	Volt amp. Measurement current: amp.	Volt amp. Measurement current: amp.
Measurement Results	Measurement Results	Measurement Results
Protective earth conductor: Ω Earth leakage current: NC mA SFC mA Enclosure leakage current: NC mA SFC mA Patient leakage current: NC mA SFC mA Mains voltage on applied part: SFC mA Patient auxiliary current: NC mA SFC mA	Protective earth conductor: Ω Earth leakage current: NC mA SFC mA Enclosure leakage current: NC mA SFC mA Patient leakage current: NC mA SFC mA Mains voltage on applied part: SFC mA Patient auxiliary current: NC mA SFC mA	Protective earth conductor: Ω Earth leakage current: NC mA SFC mA Enclosure leakage current: NC mA SFC mA Patient leakage current: NC mA SFC mA Mains voltage on applied part: SFC mA Patient auxiliary current: NC mA SFC mA